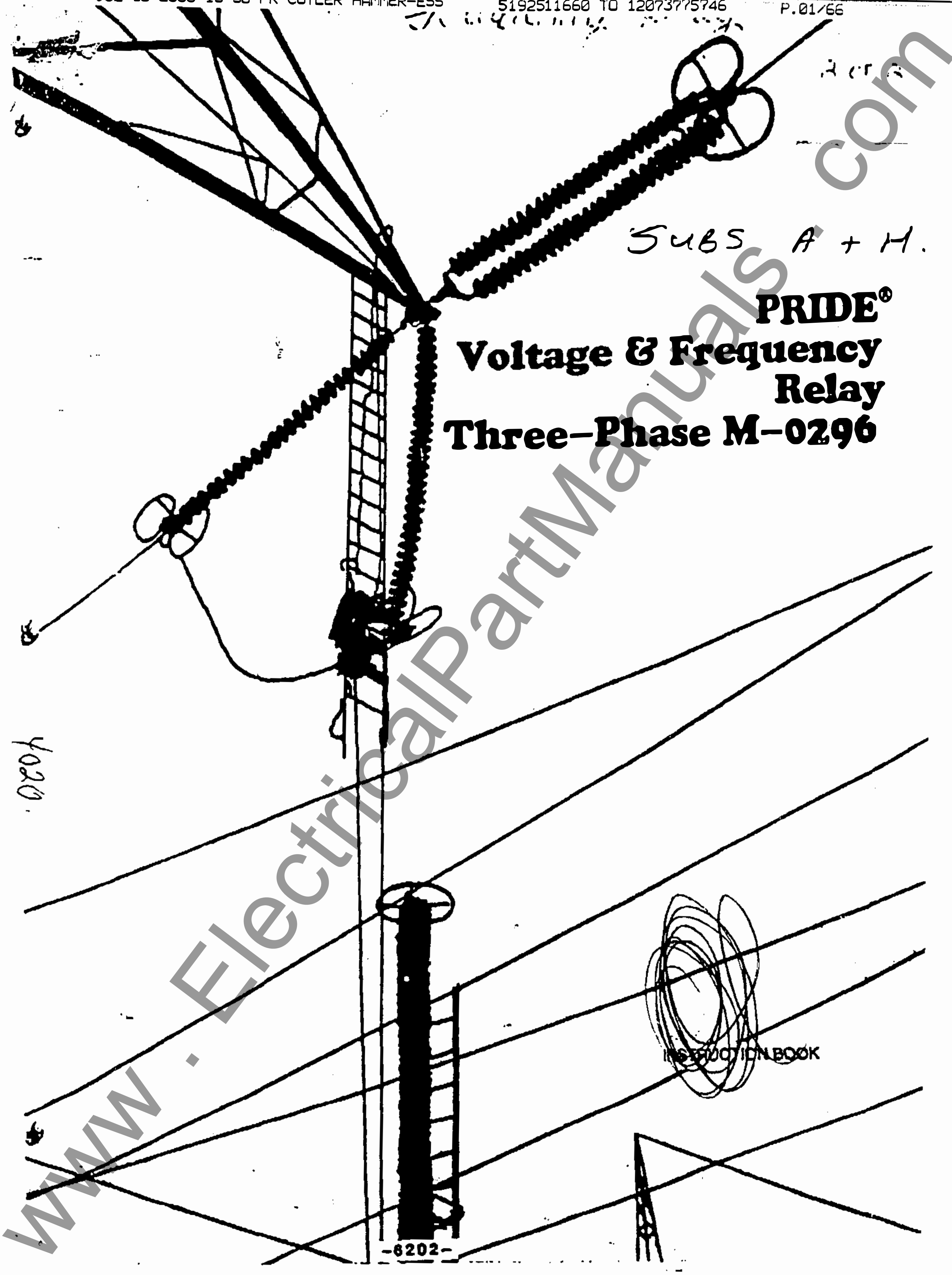
SUBS A + H.

PRIDE®
Voltage & Frequency Relay
Three–Phase M–0296



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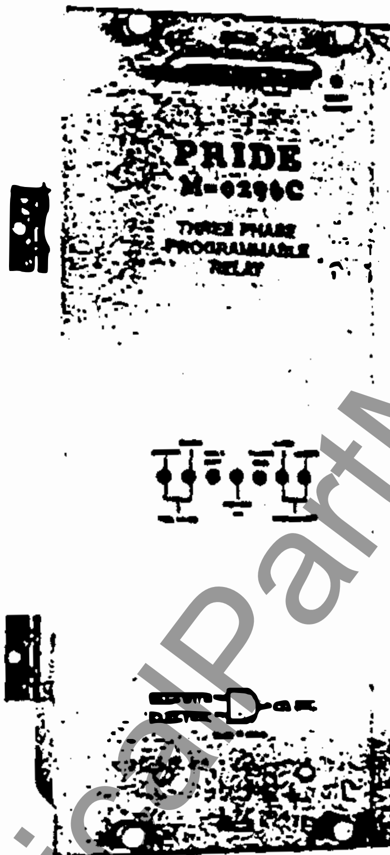
[redacted] CO. INC. *Specifications*

Voltage & Frequency Relay
Three-Phase M-0296



[redacted]ve Relay for Interconnection of Dispersed Energy

[redacted]ect Dispersed Storage and Generation (DSG) when the continued use [redacted]G would adversely affect the utility or other customers on the circuit.

[redacted]issive relay to permit reconnection of DSG when the distribution/ [redacted]on line voltage and frequency have been normal for a period longer [redacted]ngest automatic reclosing cycle in use by the utility.

[redacted]ral purpose relay for any of the following functions: overvoltage, [redacted]ge, voltage difference, over frequency, under frequency and phase

FUNCTION	AVAILABLE RANGES	ACCURACY
1. Undervoltage, any input	50% to 125% of 120 V in 1% increments	±1%
2. Overvoltage, any input	50% to 125% of 120 V in 1% increments	±1%
3. Max. Voltage Unbalance	2% to 125% of 120 V in 1% increments	±2%
4. Under Frequency	59.9 to 55 Hz in 0.1 Hz increments	±.02 Hz
5. Over Frequency	60.1 to 65 Hz in 0.1 Hz increments	±.02 Hz
6. Undervoltage Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
7. Overvoltage Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
8. Voltage Unbalance Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
9. Under Frequency Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
10. Over Frequency Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
11. Reconnect Timer*	0 to 1092 sec in 1 sec increments	***
12. Phase Sequence	Verifies proper A-B-C phase rotation (Permissive function for reconnection only; not a tripping function)	

■ NOTE:

1. Overvoltage must be programmed at least 1% higher than the Undervoltage setpoint, i.e., the minimum voltage bandwidth is 1% total.
2. Function 3 or 12 may be specified as either enabled or disabled.
3. Frequency is measured on Phase A only.
4. Functions 6 through 8 may be specified as Inverse Time delays.

* The time delay specified is an intentional delay added to the inherent measurement time of the PRIDE® Relay. The total time delay for tripping or reclosing is the sum of the appropriate delay as specified in 6, 7, 8, 9, 10 or 11 plus the measurement time of the unit. The measurement time delay is dependent on the input conditions. Refer to the PRIDE Instruction Book for further details. The M-0296 voltage measurement time delay can vary from 2 to 16 cycles depending upon input conditions.

** Value in cycles is based on an internal timer accurate to 1/2 cycle or ±1% whichever is greater (refer to note * above).

*** Value in seconds is based on an internal timer accurate to 1/2 second or ±1% whichever is greater (refer to note * above).

USER ADJUSTMENTS

In order to provide a minimum cost system, the PRIDE Relay is available without user adjustments for the twelve functions listed above. The desired limits for these functions must be specified on the purchase order. The setpoints may be changed at any time by addition of an optional M-0297/M-0397 Field Adjustment Unit which is easily installed by the user. The Field Adjustment Unit can also be used to monitor conditions such as voltage on any phase, line frequency and timer progress; and to enable or disable certain functions, as well as interrogate setpoints or trip targets.

When ordering the PRIDE Relay with the Field Adjustment Unit, the user must specify a set of fixed backup settings that will be used if the M-0397 is later removed from the PRIDE.

If the optional M-0297/M-0397 Unit is not purchased and the user wishes to change PRIDE settings, the old Memory Board model M-0298 containing the settings can be exchanged for a new one that can be installed by the user. Alternatively, additional Memory Boards are available separately from he factory.

POWER INPUT

Ac Supply: Two-wire input 80 to 140 V ac, 60 Hz ±10 Hz, 20 W max. Will withstand 170 V ac for 5 sec.

Dc Supply: Nominal input voltage 125 V dc, 48 V dc or 24 V dc; 25 W max. Operates from approximately 65% to 128% of the nominal input voltage and will withstand 150% of nominal voltage for 5 sec. Operation from 250 V dc is possible, but requires the external M-0319 Dropping Regulator option to provide 125 V dc nominal input voltage to the PRIDE.

CAPACITOR POWER HOLD-UP OPTION

Provides power for operation of Ac Supply PRIDE® Units for up to 3 sec. after loss of input power.

SENSING INPUTS

Three isolated two-wire ac inputs for phase A, B, and C
0 to 160 V ac at 60 Hz ±15 Hz, 1 W maximum.
May be connected 120 V to neutral wye or 120 V phase-to-phase delta.

OUTPUTS

Isolated Trip contact and Close contact: The user must choose between the Standard, Alternate or Pulse output relay configurations, which will determine if the output relays are energized or de-energized in the Trip state or Close state. The Trip state is defined as when any parameter is out of specification after the appropriate time delay. The Close state is defined as when all conditions are within acceptable ranges and the reconnect time is complete.

Standard Relay Configuration: Both the Trip and Close relays will de-energize when the PRIDE is in the Trip state, and energize when in the Close state.

Alternate Relay Configuration: Only the Trip relay will energize when the PRIDE is in the Trip state; only the Close relay will energize in the Close state.

Pulse Rela Configuration: Only the Trip relay will pulse energize for 0.5 sec when the PRIDE is in the Trip state; only the Close relay will pulse energize for 0.5 sec in the Close state.

When power to the unit is lost or a Self-Test error is detected, both relays will de-energize. This is the Trip state in the Standard Relay Configuration and an undefined state (neither Trip nor Close) in the Alternate or Pulse Relay Configuration.

The Standard Relay Configuration was designed to trip the unit when power is lost or when a Self-Test error occurs. The Alternate Relay Configuration is used to prevent tripping or closing due to loss of power or failures detected in the Self-Test routines. The Pulse Relay Configuration can be used in circuit breaker applications where the user wants the trip and close signals to be momentary.

The user must also choose the type of contact desired (i.e., Normally Open or Normally Closed) in the Trip state. The contact type can be changed by the user if required.

Trip/Close Relay Contact Rating: 6 A at 250 V ac, 80% P.F.; 10 A at 120 V ac, 80% P.F., make and break, 5 A at 125 V dc make and carry only. Output contacts are ot rated for interruption of dc circuits unless external arc suppression is used. Consult the factory for advice concerning dc interruption.

LED INDICATORS

The POWER OK LED will remain on as long as power is applied to the unit and the power supply is operating properly. All other LEDs will remain off when conditions are within limits. Appropriate LEDs will light when an over or under limit condition occurs.

UNDERVOLTAGE
OVERVOLTAGE
VOLTAGE DIFFERENCE

POWER OK
PHASE SEQUENCE
OVER FREQUENCY
UNDER FREQUENCY

If an error is detected in the Self-Test routine of the microprocessor, an LED will flash to indicate the source of the error. In addition, if the unit is purchased with the optional M-0297/M-0397 Field Adjustment Unit, the status LEDs can also be used to display trip target conditions by activating a pushbutton. Refer to the PRIDE Instruction Book for further details.

TESTING FEATURE

The M-0296 can be disconnected from the system inputs, using an internal connector, to allow complete functional testing off-line.

M-0315 TEST ADAPTER OPTION

The M-0315 can be purchased to ease the functional testing of the M-0296. The Test Adapter consists of a phenolic enclosure containing 14 five-way binding posts and a five-foot extension cable with two polarized plugs that connect to the PRIDE® Power Input section. The color coded binding posts are labeled to directly correspond to the rear terminal block connectors of the M-0296.

MOUNTING

The M-0296 is designed for either surface mounting or for semiflush mounting. Units specified for surface mounting will be provided with a short cable and terminal block extending below the unit. Units specified for semiflush mounting will be provided with the terminal block mounted to the rear surface. The mounting is changeable in the field. A horizontal mount front panel is available as an option.

TRANSIENT PROTECTION

The inputs and outputs are fully transient protected and will pass the ANSI C37.90.1-1974 Surge Withstand Capability (SWC) Test, which includes the Fast Transient SWC Test. All inputs and outputs will withstand 1500 V ac, 60 Hz to chassis or instrument ground for one minute. The relay will meet ANSI C37.90-1971 standard on protective relays. Potential inputs are electrically isolated from each other, from other circuits and from ground.

ENVIRONMENTAL

Temperature: Stated accuracies are maintained from -40° C to +80° C.
Humidity: Stated accuracies are maintained under 85% relative humidity (non-condensing).
Fungus Resistance: A conformal printed circuit board coating inhibits fungus growth.

PHYSICAL

Size: 17-7/16" high X 7-5/16 wide X 6-5/16" deep (44.29 cm X 18.57 cm X 16.03 cm).
Approximate Weight: 15 lb (6.80 kg).
Approximate Shipping Weight: 17 lb (7.70 kg).

OPTIONS

M–0296 PRIDE® VOLTAGE & FREQUENCY RELAY (THREE-PHASE)

The options for the M–0296 are listed below. If you are ordering a unit, please check either YES or NO for each option listed, sign and fill out the form at the bottom. Beckwith Electric will maintain a copy on file as a record of your unit. A copy of this form will appear in all manuals and on the unit. If you have received a unit, please check to see that the settings indicated agree with those ordered. The serial number on the CERTIFICATION page of the manuals and on the unit should agree.

	YES	NO
POWER INPUT		
A. AC SUPPLY	[ ]	[ ]
B. CAPACITOR HOLD-UP OPTION (Ac Supply Units Only)	[ ]	[ ]
C. DC SUPPLY (Nominal Dc Voltage)		
1) 24 V dc	[ ]	[ ]
2) 48 V dc	[ ]	[ ]
3) 125 V dc	[ ]	[ ]
D. M-0319 DROPPING REGULATOR Required for operation from 250 V dc. (Specify 125 V dc for nominal Dc voltage)	[ ]	[ ]
OUTPUT RELAYS		
• E. TRIP CONTACT		
1) Open	[ ]	[ ]
2) Closed	[ ]	[ ]
• F. CLOSE CONTACT		
1) Open	[ ]	[ ]
2) Closed	[ ]	[ ]
G. MOUNTING		
1) Surface Mount	[ ]	[ ]
2) Semiflush Mount	[ ]	[ ]
3) Horizontal Mount Panel	[ ]	[ ]
FIELD ADJUSTMENT UNIT		
H. M-0297 PRIDE CONTROL UNIT	[ ]	[ ]
I. M-0397 EE PROM BOARD	[ ]	[ ]
J. M-0315 PRIDE TEST ADAPTER	[ ]	[ ]

• ■ NOTE: Output Relay in Tripped State, i.e., conditions outside of setpoints.

Signature ______________________________

Company ______________________________

Your Purchase Order No. ______________________________

Date ______________________________

Beckwith Electric Style Number (Optional) M–0296– ______________________________

SETPOINTS

PRIDE® VOLTAGE & FREQUENCY RELAY THREE-PHASE M-0296

If you do not order the M-0297/M-0397 Field Adjustment Unit installed in the PRIDE, ignore the right-hand column below and fill in the setpoint values for the functions shown in the left-hand column. Your settings will then be programmed into the PRIDE at the factory.

If you do order the M-0297/M-0397 to allow the setpoints to be field adjustable, a set of fixed backup settings is also programmed into the PRIDE to be used if the Field Adjustment Unit is later removed. If the FACTORY SETTINGS shown in the right-hand column are acceptable, you need not fill out the CUSTOMER SETTINGS. Otherwise, fill in the desired settings in the left-hand column.

CUSTOMER SETTINGS	YES	NO	FACTORY SETTINGS YES	FACTORY SETTINGS NO
VOLTAGE UNBALANCE FUNCTION	[ ]	[ ]	[✔]	[ ]
PHASE SEQUENCE FUNCTION	[ ]	[ ]	[✔]	[ ]

CUSTOMER SETTINGS	FACTORY SETTINGS
UNDERVOLTAGE ________% of 120 V*	90%
OVERVOLTAGE ________% of 120 V*	110%
VOLTAGE UNBALANCE ________% of 120 V*	20%
UNDER FREQUENCY ________HZ	59 HZ
OVER FREQUENCY ________HZ	61 HZ
UNDERVOLTAGE TRIP TIMER:	
FIXED ________CYC	FIXED 30 CYC
or INVERSE [N_u = ________; T_{uv} = ________CYC]	
OVERVOLTAGE TRIP TIMER:	
FIXED ________CYC	FIXED 10 CYC
or INVERSE [N_o = ________; T_{ov} = ________CYC]	
VOLTAGE UNBALANCE TRIP TIMER:	
FIXED ________CYC	FIXED 300 CYC
or INVERSE [N_v = ________; T_b = ________CYC]	
UNDER FREQUENCY TRIP TIMER ________CYC	30 CYC
OVER FREQUENCY TRIP TIMER ________CYC	30 CYC
RECONNECT TIMER ________SEC	1 SEC

RELAY CONFIGURATION

	YES	NO	YES	NO
STANDARD	[ ]	[ ]	[✔]	[ ]
ALTERNATE	[ ]	[ ]	[ ]	[✔]
PULSE	[ ]	[ ]	[ ]	[✔]

*■NOTE: If using an input voltage other than 120 V (i.e., 115 V), please convert percentages to a base voltage of 120 V. The Overvoltage Setpoint must be at least 1% higher than the Undervoltage Setpoint, i.e., the minimum voltage bandwidth is 1% total.

Signature ______________________________

Company ______________________________

Your Purchase Order No. ______________________________

Date ______________________________

CERTIFICATION

This manual contains the most current and complete information available for the following piece of Beckwith Electric equipment.

MODEL NUMBER PRIDE® Voltage & Frequency Relay Three-Phase M-0296, Serial Numbers 0800 and above.

UNIT SERIAL NUMBER(S) __________

MEMORY BOARD SERIAL NUMBER __________
(Stamped on printed circuit board.)

SOFTWARE VERSION NUMBER __________
(Stamped on ROM Chips.)

EE PROM BOARD SERIAL NUMBER __________
(Stamped on printed circuit board.)

SOFTWARE VERSION NUMBER __________
(Stamped on ROM Chips.)

CHECKED BY __________

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WARNING

DANGEROUS VOLTAGES, CAPABLE OF CAUSING DEATH OR SERIOUS INJURY, ARE PRESENT ON THE EXTERNAL TERMINALS AND INSIDE THIS EQUIPMENT. USE EXTREME CAUTION AND FOLLOW ALL SAFETY RULES WHEN HANDLING, TESTING OR ADJUSTING THE EQUIPMENT.

PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or re of this equipment. Failure to do so will violate standards for safety in the design, manufacture and intended use of the prod Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes liability for the customer's failure to comply with these requirements.

ALWAYS GROUND THE EQUIPMENT

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test the chassis must be attached to a separate ground since it is not grounded by external connections.

DO NOT OPERATE IN AN EXPLOSIVE ENVIRONMENT

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible f explosion.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove the metal cover or expose the printed circuit board while power is applied. In no cas components be replaced with power applied. In some instances, dangerous voltages may exist even when power is discon To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

EXERCISE CARE DURING INSTALLATION, OPERATION AND MAINTENANCE PROCEDURES

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified pe should install, operate, test and maintain this equipment. Be sure that all personnel safety procedures are carefully fo Exercise due care when operating or servicing alone.

DO NOT MODIFY EQUIPMENT

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair f preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure th features are maintained.

PRODUCT CAUTIONS

Before attempting any test, calibration or maintenance procedure, personnel must be completely familiar with the circuitry of this unit and have an adequate understanding of field effect devices. If a component is found to be defectiv follow replacement procedures carefully to assure safety features are maintained. Always replace components with thos or better quality as shown in the Parts List of the Instruction Book.

AVOID STATIC CHARGE

If this unit contains MOS circuitry, it can be damaged by improper test or rework procedures. Care should be taken to a charge on work surfaces and service personnel.

USE CAUTION WHEN MEASURING RESISTANCES

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instru is likely to cause damage to the unit.

TABLE OF CONTENTS

PRIDE® VOLTAGE & FREQUENCY RELAY
Three-Phase M-0296
Instruction Book

In our efforts to provide accurate and informative technical literature, suggestions to improve the clarity or to correct errors will receive immediate attention. Please contact the Marketing Services Department, specifying the publication and page number.

INTRODUCTION

THE NEED

Since the enactment of the National Energy Act of 1979, a large number of small private energy producers have been planning and building small generation facilities in order to sell power to the local utility. Electric utilities across the country have been planning for interconnection of these small generators and have been working on solutions to the associated problems that interconnection creates. Previously, the privately-owned sources of generation were typically large industrial plants with multi-megawatt generators connected to the power system at a substation through a dedicated line. Many of the new smaller sites (less than about 3 MW) are connected directly to the closest distribution circuit. With this configuration, the parallel generator may now energize a distribution line after the substation breaker or line recloser has opened. In some cases, the small generator could support the load and operate as an isolated system.

Utility specifications for the safe interconnection of these small generators generally require voltage and frequency relays that can detect when a line is isolated from the system. The PRIDE® Unit was designed to provide a multifunction relay in one package that would supply the voltage and frequency relaying required to prevent dangerous excursions in voltage or frequency.

In addition, the high-speed operation and processing power make the microprocessor-based PRIDE Relay ideally suited for more complex programming of other protective relay functions. The PRIDE Unit, therefore, is applicable as a general purpose, multifunction protective relay.

BACKGROUND

A survey was conducted of the two hundred largest utilities and of the IEEE Dispersed Storage and Generation (DSG) Working Group concerning utility relaying policies relating to interconnection of parallel generation. Upon completion of this survey, a second, more specific survey was taken of those who responded to the first survey. The second survey included a preliminary specification for a relay intended to satisfy many of the interconnection relaying requirements for small dispersed generators to the utility grid. The results of the two surveys were formulated into a design specification for a multifunction relay that would satisfy many of the DSG relaying requirements that appeared to be common among the various interconnection schemes and that would also be suitable as a general purpose protective relay, with a different program and minor hardware changes, if required.

Through our research, the need for a single-phase and a three-phase relay became apparent. The single-phase relay needed to be low-cost due to the economics of small single-phase installations. Several compromises in functional flexibility were made in the single-phase design to meet the cost goals. The three-phase relay was designed to obtain as much flexibility in application as possible.

This manual describes the Three-Phase M-0296 PRIDE Voltage & Frequency Relay only. A separate manual gives a complete description of the Single-Phase M-0290 PRIDE Voltage & Frequency Relay.

APPLICATION

■ NOTE: This instruction book is to be used with the Three-Phase M-0296C PRIDE® Voltage & Frequency Relays with serial numbers 0800 and above. Due to design changes, the information in this manual may not be correct for other serial numbers.

RELAYING FUNCTIONS

The main relaying functions chosen for the PRIDE Unit were targeted at the problem of detecting an abnormal condition on the distribution circuit, as evidence of isolation, and then tripping the small generator. However, the flexibility of the PRIDE has been increased as additional features were added. The M-0296 can now be used in a variety of applications where a multifunction voltage and frequency relay is needed. The relaying provided is listed in Table 1. Refer to the ***SPECIFICATIONS*** for a complete description of the adjustment ranges and of the accuracy of each of the relaying functions.

M-0296 FUNCTION	DEVICE THREE-PHASE
Undervoltage	27
Overvoltage	59
Voltage Unbalance	60
Under Frequency	81U
Over Frequency	81O
Undervoltage Trip Timer	2UV
Overvoltage Trip Timer	2OV
Voltage Unbalance Trip Timer	2 ΔV
Under Frequency Trip Timer	2UF
Over Frequency Trip Timer	2OF
Reconnect Timer	2Reclose
Phase Sequence	47

TABLE 1 Relaying Functions

OPERATING PRINCIPLES

FUNCTIONAL DESCRIPTION

In order to understand the operation of the microprocessor-based relay, refer to the Functional Diagram shown in Figure 1. This diagram indicates the mix of hardware and software and represents the software in a logical form, but does not represent the actual mechanization of the relays or the flow of the program. However, it is useful in understanding how the various relaying functions are combined, the hardware/software mix and the overall operation of the unit.

The Three-Phase M-0296 incorporates an A/D converter and an Analog Multiplexer controlled by the microprocessor. The three-phase voltages are converted to square waves at logic voltage levels and are used by the microprocessor for frequency and phase sequence calculations. The Analog-A/D Board is a plug-in module that contains the A/D converter, analog multiplexer and the Ac/Dc converters. These components are used to scan the input phase voltages and convert the ac amplitude information to binary numbers under microprocessor control.

The binary information is then fed to the microprocessor and is stored in the system RAM (Random Access Memory). The processor continuously sequences through the three-phase voltages and stores the binary data. The voltage relaying then uses the binary voltage information to perform the following functions:

1. Overvoltage Detection
2. Undervoltage Detection
3. Voltage Unbalance Detection
4. Input Loss Detection

The overvoltage and undervoltage functions compare the binary voltage data to the limits stored in the processor memory. The voltage unbalance function calculates the maximum difference in the phase voltages and compares this difference voltage to the limit settings.

The frequency and phase sequence calculations require reliable reproduction of the period of the input ac potentials. Input Loss Detection is used to determine if sufficient potential or sensing input voltage is available for a reliable measurement of frequency and phase sequence.

Three types of Input Loss Detection are incorporated in the software of the PRIDE® Units.

1. Any frequency measurement above 80 Hz and below 40 Hz will be ignored. This is the Frequency Blocked State and will be indicated by both frequency LEDs turning on.

2. If no zero-crossings are detected for approximately 0.5 sec or if the Phase A voltage falls below 0.45 p.u., the frequency measurement will also be blocked; therefore, frequency cannot initiate tripping. The reason for this implementation is to allow the undervoltage condition to trip the relay.

3. Upon Power Up, the Phase A potential must be above 0.45 p.u. for the unit to pass the Power Up Self-Tests and completely initialize. If Phase A is not connected or there is insufficient voltage present, the UNDER FREQUENCY LED will flash to indicate an input loss failure.

If the Phase A input is lost or if a "noisy" loss occurs and the Under Frequency Trip Timer is set extremely low (1 to 3 cycles), there may be a chance that the Under Frequency Trip Timer may time out before the loss can be detected and the frequency timers can be blocked. Refer to the section on **CHOOSING LIMIT SETTINGS** for recommended Trip Timer settings.

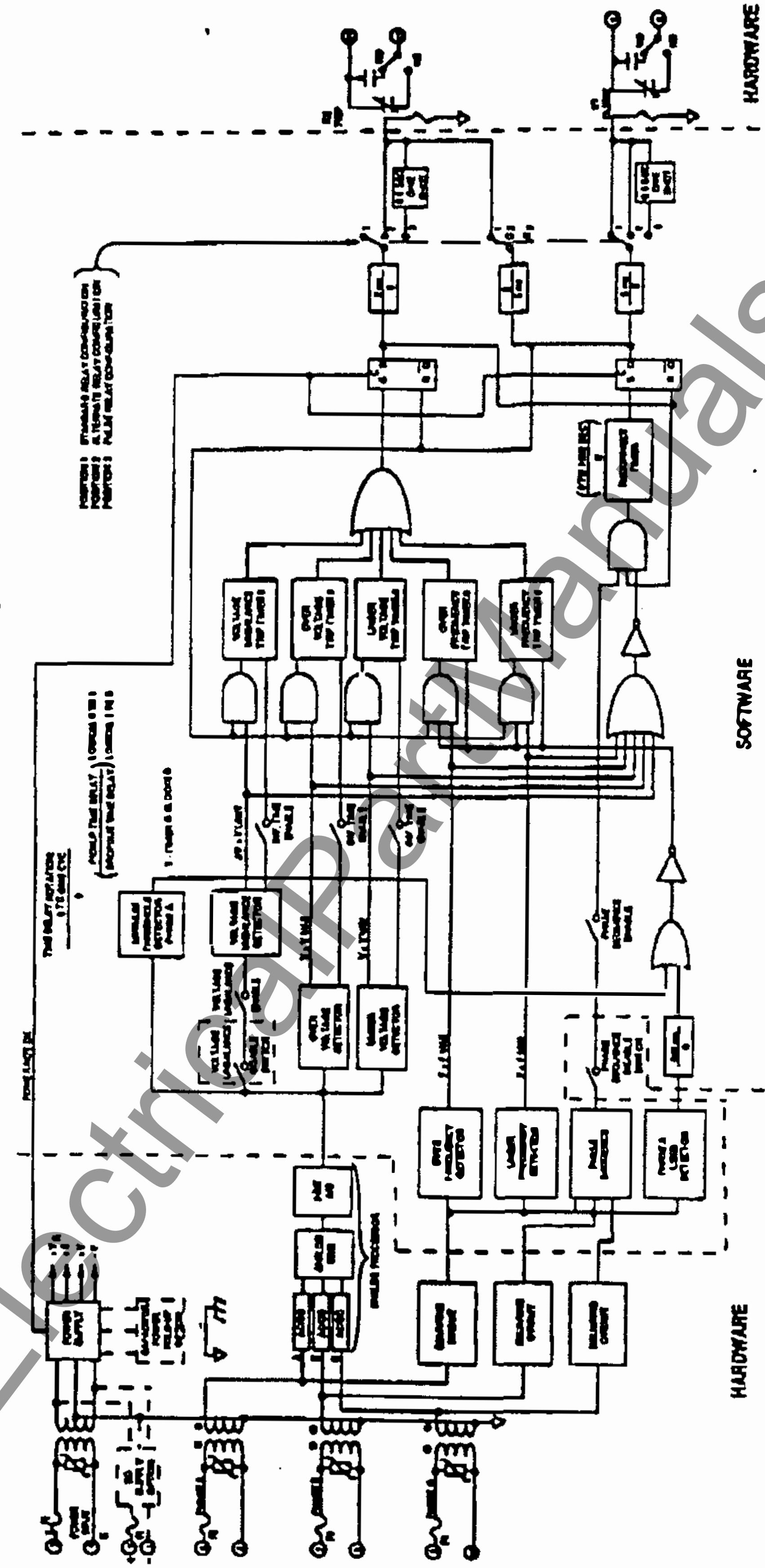


FIGURE 1 Functional Diagram

The frequency will also be blocked if the rate of change of frequency (ΔF) is greater than 1 Hz/cycle in successive period measurements. This ΔF Transient Protection will prevent noise spikes from triggering the frequency timers.

■ NOTE: If one of the three-phase voltages is used to power the PRIDE® Unit, refer to the POWER LOSS DETECTOR section under ELECTRICAL DESCRIPTION for further details.

The frequency and phase sequence functions use a counter in the microprocessor to determine the period and relative phase rotation of the three inputs. The period is calculated after each cycle. A digital filter in the processor software filters the period data to reduce the effect of phase jitter on the measurement. The filtered period data is then compared to the upper and lower limits stored in the processor memory. Since the period is the reciprocal of frequency, the Over/Under Frequency function is accomplished.

Dynamic hysteresis is incorporated in the frequency measurement routine. While the trip point always remains absolute, the point where the frequency returns within the setpoint range will vary as follows:

$$F_r = \frac{F_s}{F_s(.002083) + 0.875} \qquad (1)$$

Where: F_s = Over or Under Frequency setpoint (Hz)

F_r = Frequency return point (Hz)

Therefore, the farther the setpoint is from its base, the greater the hysteresis.

The Phase Sequence function is permissive for reconnect only. Improper phase sequence will not cause the relay to trip if previously reconnected. However, it will block reconnection if previously tripped. The PHASE SEQUENCE status LED is active whether the relay is tripped or reconnected, unless the Phase Sequence function has been disabled.

The microprocessor samples the squared up waveforms from the three-phase inputs to determine if the proper A-B-C phase rotation is present. This method will detect most wiring errors (polarity reversals) and block reconnection.

The time delays for tripping and reclosing use an internal crystal oscillator as a clock. The time delays in Figure 1 provide a delay only on an input transition from a logic low to a logic high. No delay is incorporated from a logic high to a logic low. The voltage and frequency time delays are used to delay tripping, ensuring that a transient condition will not cause an unnecessary trip. The Reconnect Timer can be programmed for up to 1092 seconds to ensure the system is stable and reclosers have all completed their sequences before reconnection.

OUTPUT RELAY CONFIGURATION OPTIONS

As stated in the ***SPECIFICATIONS*** and shown in Figure 1, one of the following three output relay configurations is possible.

The Standard Relay Configuration (Position 1) will be used in most DSG applications where any power loss or Self-Test error will cause the relays to de-energize. This is defined as the Tripped state in this configuration.

The Alternate Relay Configuration (Position 2) will be used in larger powerplant applications, where a Self-Test error or power loss to the unit will not cause the PRIDE® to trip the generator off-line. When in the Alternate Relay Configuration, the appropriate output relay will energize when its condition is met (i.e., when a Trip Timer times out, the Trip output relay will energize). Self-Test errors or power loss will de-energize the output relays, causing an undefined (neither Tripped nor Closed) state.

The Pulse Relay Configuration (Position 3) is logically the same as the Alternate Relay Configuration, except the appropriate output relay will only energize for 0.5 sec when its condition is met. This option will be used in circuit breaker applications where the trip and close signals will be momentary.

■ NOTE: It is important to remember that the three Output Relay Configuration options are separate from the the Output Contact option, which is chosen as normally open or normally closed.

The Output Relay Configuration can be selected at the time of purchase or by using the M-0297/M-0397 Field Adjustment Unit.

INVERSE TIME DELAY OPTION

The Overvoltage, Undervoltage and Voltage Unbalance time delays on the M-0296 can be programmed as inversely proportional to the Over/Undervoltage or Voltage Unbalance setpoints, or as fixed times. The available inverse time delay curves are shown in Figures 2 through 5.

The time delay curves are specified by the selected value of N_u, N_o, or N_s. A fixed time delay is set by choosing a value of $N_{( )} = 0$. The values that can be selected for $N_{( )}$ are limited to the seven curves shown for Undervoltage, Overvoltage or Voltage Unbalance.

UNDERVOLTAGE: (Figures 2 and 3)

The Undervoltage inverse time delay is described by the following equation:

$$T_u(V_L) = \frac{T_u}{INT\left\{\dfrac{V_{su} - V_L}{N_u}\right\} + 1} + T_{meas} \qquad (2)$$

Where:

- $T_u(V_L)$ = Undervoltage time delay as a function of V_L.
- V_L = Voltage of the lowest input phase in % of 120 V.
- T_u = The maximum time delay specified at slightly less than the undervoltage setpoint (1 to 9999 cycles).
- V_{su} = Undervoltage setpoint in % of 120 V.
- N_u = Curve number (Undervoltage).
- INT{} = Integer value of the resultant number inside the brackets with all numbers to the right of the decimal point truncated.
- T_{meas} = M-0296 measurement time. Refer to the TOTAL TIME DELAY CALCULATION section.

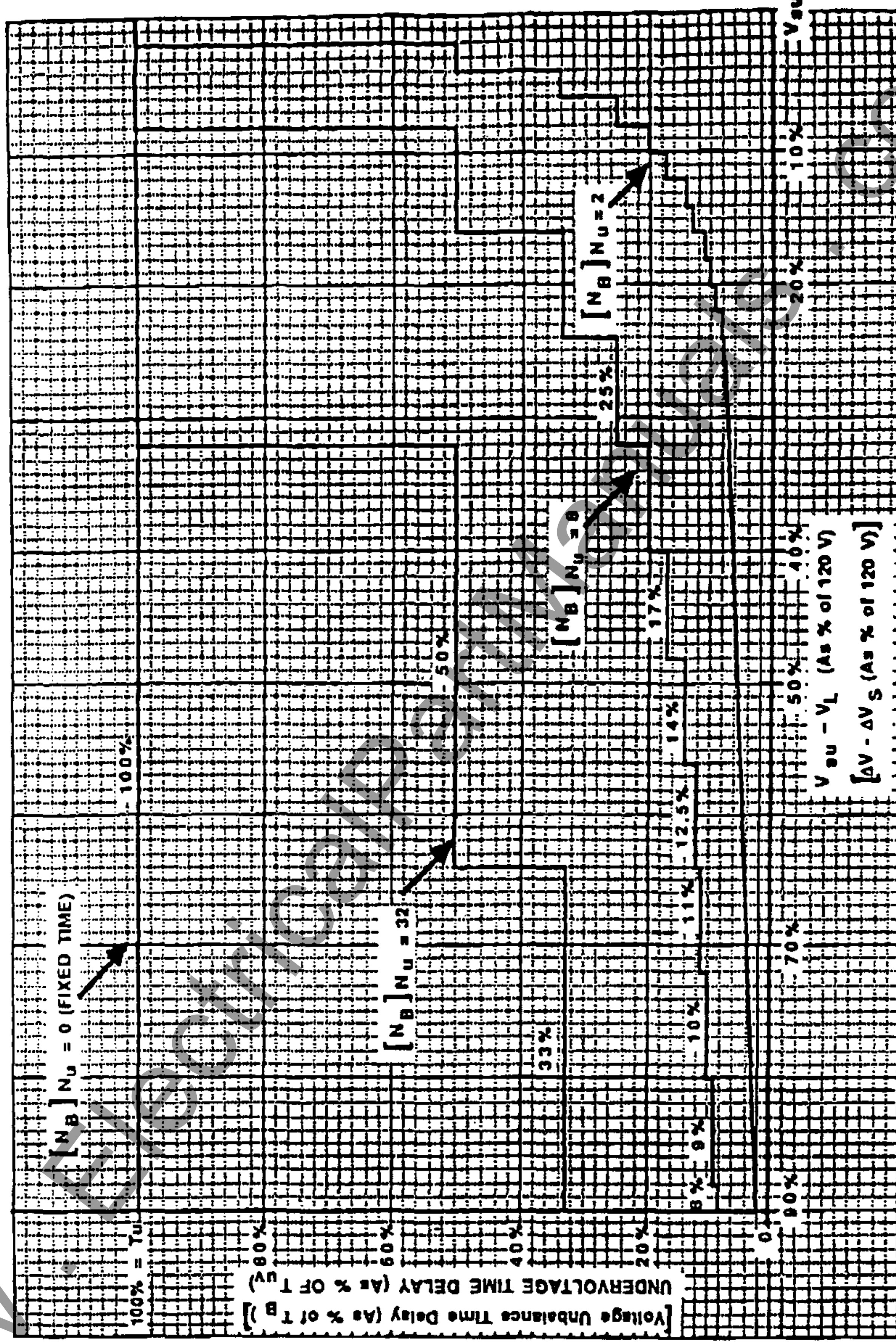


FIGURE 2 Undervoltage Time Delay Curves for N_u = 0, 2, 8, & 32
[Voltage Unbalance Time Delay Curves for N_B = 0, 2, 6 & 32]

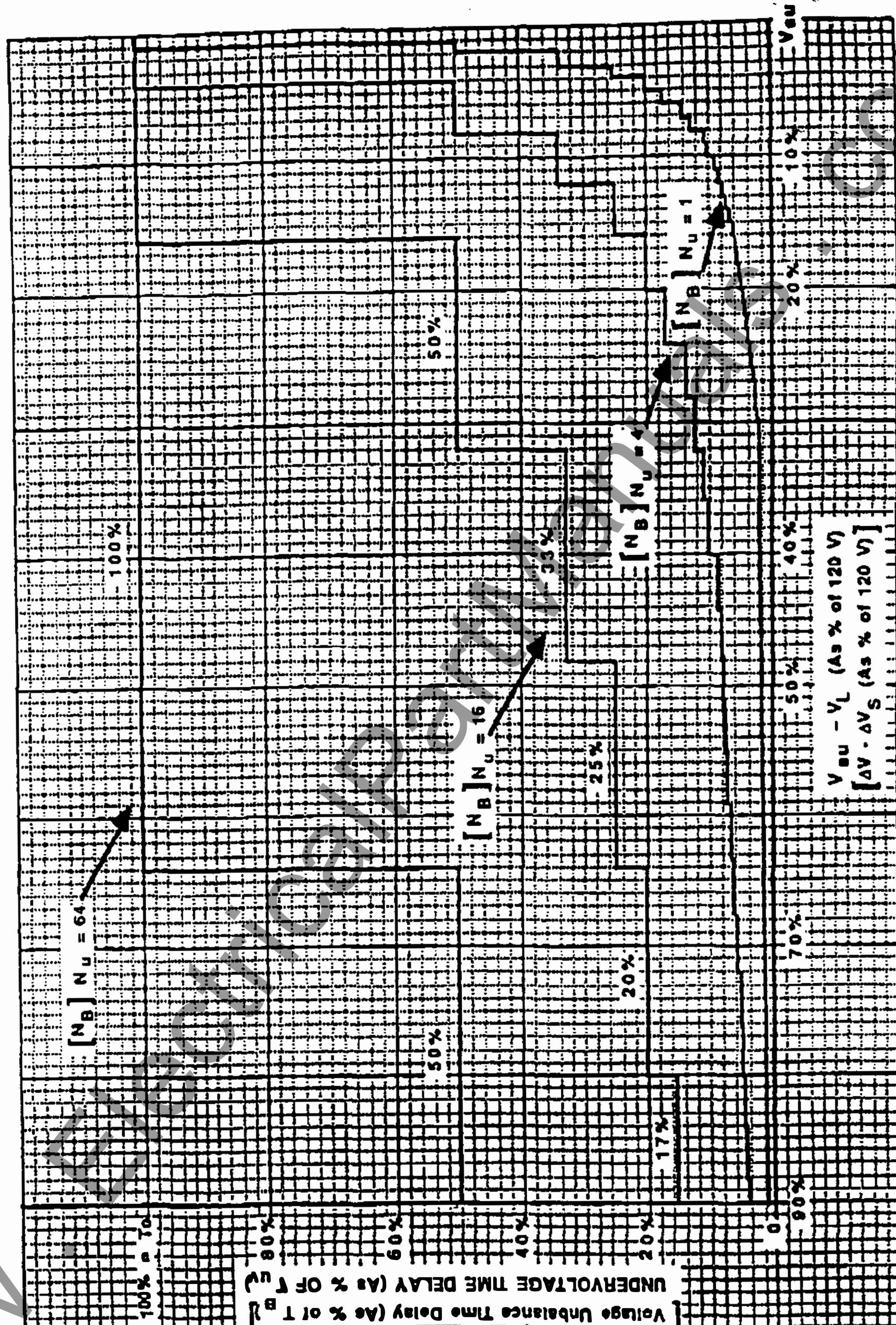


FIGURE 3 Undervoltage Time Delay Curves for N_u = 1, 4, 16, & 64
[Voltage Unbalance Time Delay Curves for N_B = 1, 4, 16, & 64]

The time delay curve is specified by the values of T_u, V_{uv}, and N_u programmed into the M–0296. The microprocessor measures the lowest of the three-phase voltages (V_L) and uses the equation for $T_u(V_L)$ to determine the time delay.

OVERVOLTAGE: (Figures 4 and 5)

The overvoltage inverse time delay is described by the following equation:

$$T_o(V_H) = \frac{T_o}{INT\left\{\frac{V_H - V_{ov}}{N_o}\right\} + 1} + T_{meas} \qquad (3)$$

Where: $T_o(V_H)$ = Overvoltage time delay as a function of V_H.

V_H = Highest of the three-phase voltages (maximum measured value is 128%) in % of 120 V.

T_o = The maximum time delay for overvoltage specified at an input just slightly greater than the overvoltage setpoint (1 to 9999 cycles).

V_{ov} = Overvoltage setpoint in % of 120 V.

N_o = Curve number (Overvoltage).

INT{ } = Integer value of the resultant number inside the brackets with all numbers to the right of the decimal point truncated.

T_{meas} = M–0296 measurement time. Refer to the TOTAL TIME DELAY CALCULATION section.

■ NOTE: The time delay is constant for all voltages above 128%. To determine the delay, calculate T_o(128%).

The time delay curve is specified by the values of T_o, V_{ov}, and N_o programmed into the M–0296.

VOLTAGE UNBALANCE: (Figures 2 and 3)

The voltage unbalance inverse time delay is described by the following equation:

$$T_s(\Delta V) = \frac{T_s}{INT\left\{\frac{\Delta V - \Delta V_s}{N_s}\right\} + 1} + T_{meas} \qquad (4)$$

Where: $T_s(\Delta V)$ = Voltage Unbalance Time Delay as a function of ΔV.

ΔV = The voltage difference between the highest and lowest values of the three-phase voltages in % of 120 V.

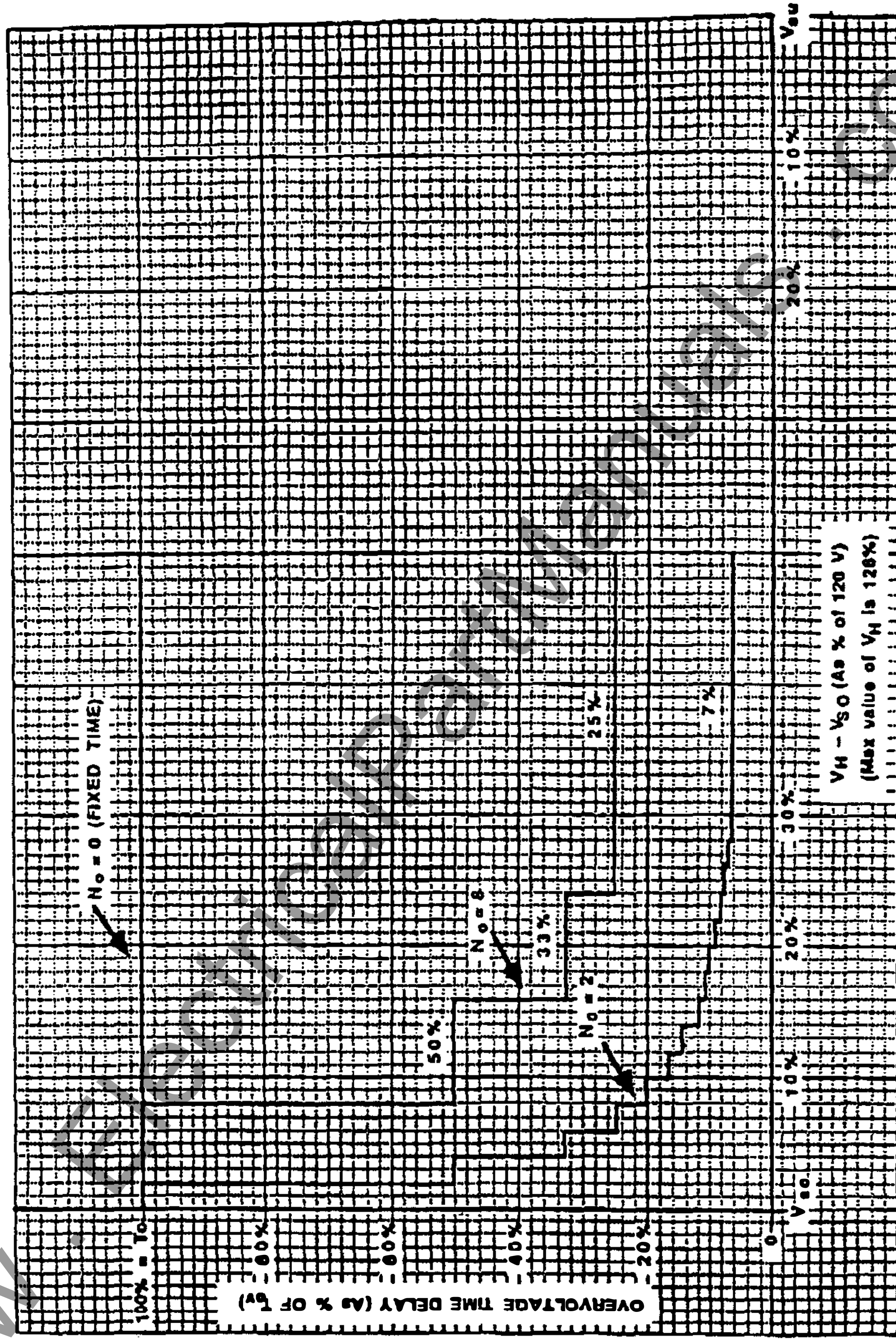


FIGURE 4 Overvoltage Time Delay Curves for N_o = 0, 2 & 8

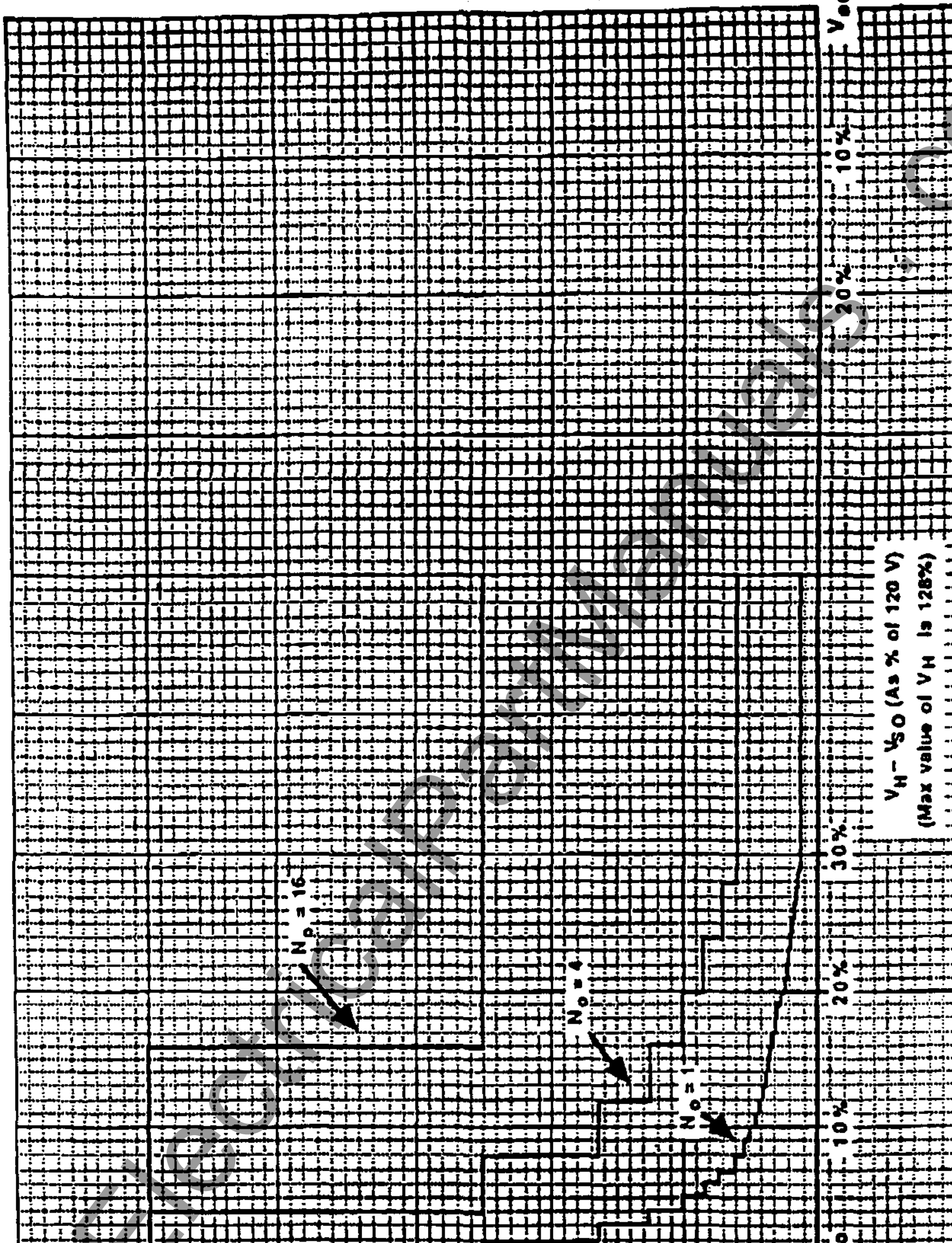


FIGURE 5 Overvoltage Time Delay Curves for N_o = 1, 4 & 16

T_3 = The maximum time delay for a value of ΔV slightly greater than the voltage unbalance setpoint (1 to 9999 cycles).

ΔV_S = Voltage Unbalance setpoint in % of 120 V.

N_3 = Curve Number (Voltage Unbalance).

INT( ) = Integer value of the resultant number inside the brackets.

The Voltage Unbalance Inverse Time Delay curve is specified by the values of T_3, V_S, and N_3 programmed into the M-0296. The Undervoltage Inverse Time Delay curves (Figures 2 and 3) can be used to determine the shape of the Voltage Unbalance Inverse Time Delay curve. The horizontal axis would be "$\Delta V - \Delta V_S$ (in % of 120 V)". The vertical axis will be "Time Delay (as % of T_3)".

■ NOTE: The Voltage Measurement Time (T_{meas}), as discussed in the following section, should be considered when choosing a time delay value. The M-0296 continuously measures the three-phase voltages, taking samples approximately every 4 ms. The M-0296 uses the last three-phase voltage samples to do the time delay calculations. The undervoltage function uses the lowest of these three to determine the time delay and the overvoltage uses the highest, as discussed previously. The measurement time should be added to the programmed time delay to get the total time for trip.

TOTAL TIME DELAY CALCULATION

The total time delay for the PRIDE® to trip or close is composed of two independent components:

1. The time delays specified in the Under/Overvoltage Trip Timers, Voltage Unbalance Trip Timer, Under/Over Frequency Trip Timers and Reconnect Timer.
2. The measurement time delay for the internal circuitry to detect the change in the input condition.

The measurement time must be added to the time delay specified for the Under/Overvoltage Trip Timers, Voltage Unbalance Trip Timer, Under/Over Frequency Trip Timers and Reconnect Timer.

The measurement time is defined as the time between the change in the input condition (i.e., the voltage or frequency shift) and the front panel LED turning on (or alternately turning off for an input condition shifting into range).

The intentional time delay programmed in the Trip Timers or the Reconnect Timer can be determined by measuring the time delay between when the LED changes state and when the relay contact changes state. A technique to determine a close approximation of what the measurement time delay will be for various input conditions is described in the following sections.

VOLTAGE MEASUREMENT TIME

The time required for the M-0296 to detect an over or undervoltage condition is dependent on the voltage level before and after the voltage change and the setpoint of the over/undervoltage detector. In case the potential input drops to zero volts from its nominal 100% value, the following time delays for measurement can be expected.

Undervoltage Setting	Measurement Time Delay
5%	2 cycles
10%	2.5 cycles
20%	3.25 cycles

Longer measurement delays can be expected if the input change is less. For example, if the input voltage drops from 100% to 75% and the undervoltage setting is 80%, a measurement delay of 8.5 cycles can be expected.

The measurement time delay for either under or overvoltage can be calculated from Figure 6. This figure can be used for either an increase or decrease in the input voltage if the voltage setpoint is between the initial voltage and the final voltage. The following two examples are shown to clarify this technique. Refer to Figure 6 for definitions of the terms.

Example 1.

Initial Voltage = 120 V
Final Voltage = 140 V
Setpoint = 130 V

Vstep = 20 V
Vset = 10 V

$$\frac{Vset}{Vstep} = \frac{(130 - 120)}{(140 - 120)} \times 100\% = \frac{10}{20} \times 100\% = 50\%$$

Time Delay (from Figure 6) = 5.5 cycles (0.092 sec)

Example 2.

Initial Voltage = 120 V
Final Voltage = 100 V
Setpoint = 108 V

$$\frac{Vset}{Vstep} = \frac{(120 - 108)}{(120 - 100)} \times 100\% = \frac{12}{20} \times 100\% = 60\%$$

Time Delay (from Figure 6) = 6.25 cycles (0.105 sec)

FREQUENCY MEASUREMENT TIME

The time required for the M-0296 to detect an over or under frequency condition is dependent on the frequency before and after an input frequency step change, the setpoint for the Over/Under Frequency detector and the rate of change of frequency. The frequency is measured each cycle of the potential input (Phase A only). A digital filter is used in the microprocessor to filter the data. This filter can add time delay dependent on how the input changes relative to the setpoint. Figure 7 shows how the filter output changes for a change in input frequency. If the rate of change of frequency is greater then 1 Hz/cycle in successive period measurements, that measurement will be ignored. This is to prevent short time noise transients from triggering the frequency detector. This could add one additional cycle to the measurement delay for sharp step change inputs.

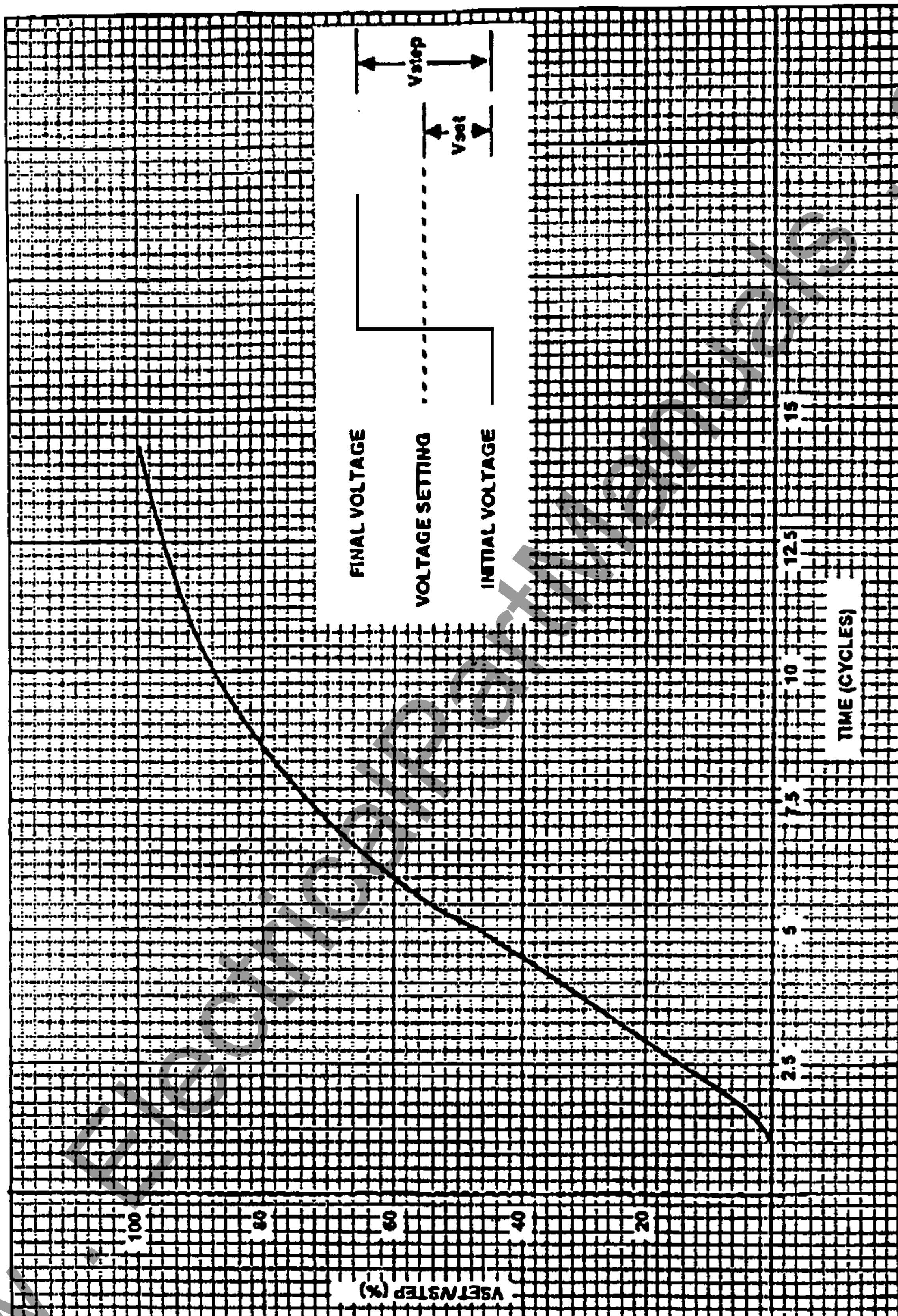


FIGURE 6 Voltage Measurement Time Curve

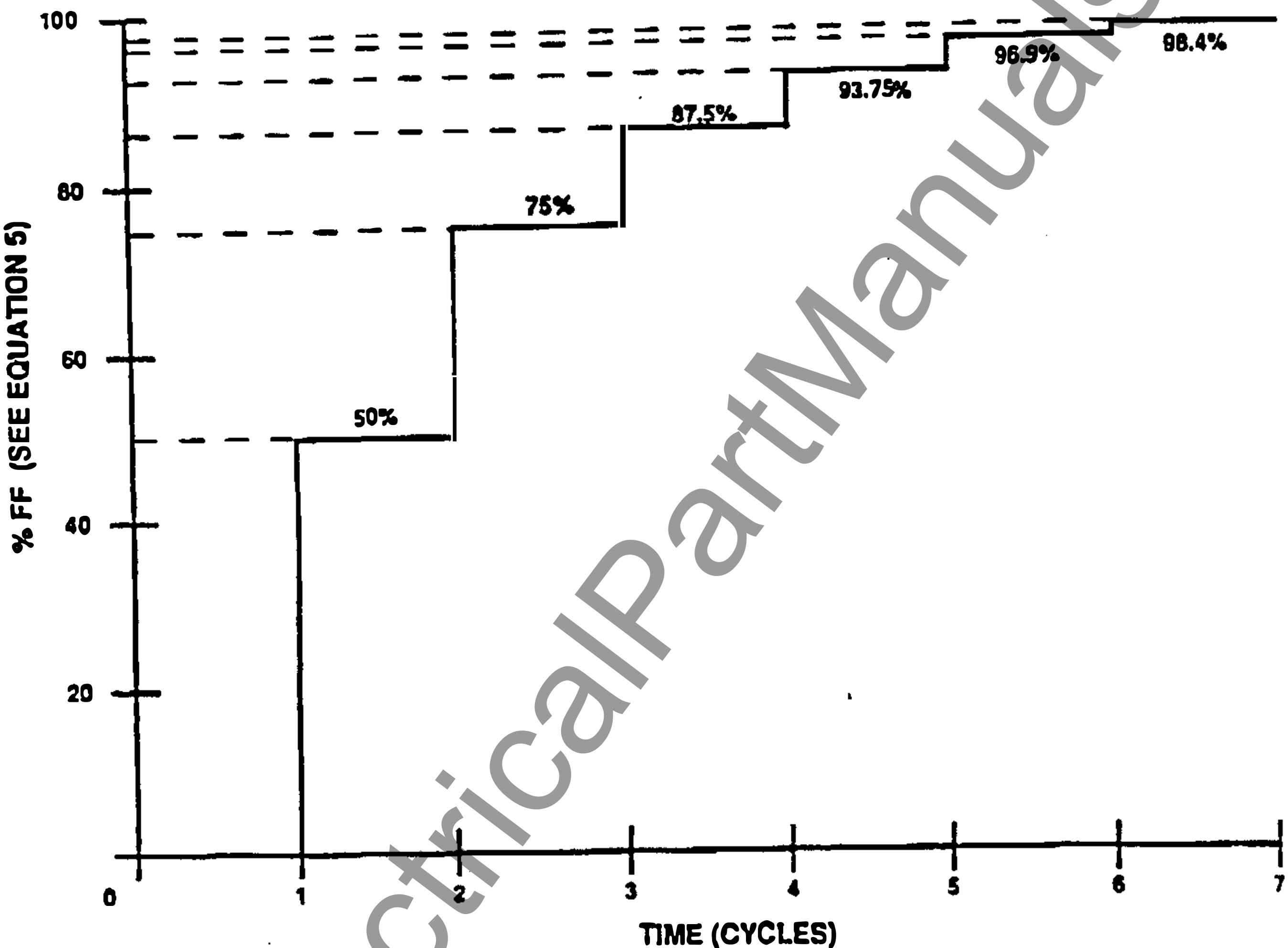


FIGURE 7 Frequency Measurement Time Curve

Using the vertical scale of Figure 6 (labeled "% FF"), the measurement time delay can be determined for any frequency step change. Negative frequency step changes are treated the same as positive changes.

$$FF = \frac{\text{Initial Frequency} - \text{Frequency Setting}}{\text{Initial Frequency} - \text{Final Frequency}} \times 100\% \quad (5)$$

A step change from 60 Hz to 55 Hz with an Under Frequency setting of 58 Hz would be detected in two cycles after the change.

The digital filter is implemented as follows:

$$F_{(nt)} = \frac{F_{(n-1)}t + Fs_{(nt)}}{2} + 1 \text{ cycle} \quad (6)$$

Where:
- $F_{(nt)}$ = Filter output at time nt
- $F_{(n-1)}t$ = Filter output at time $_{(n-1)}t$
- $Fs_{(nt)}$ = Latest frequency sample at time nt

SYSTEM SOFTWARE DESCRIPTION

■ NOTE: There are a number of words used by the power industry and by the computer industry that appear to be similar but, in fact, have very different meanings. The following section refers to the definitions used by the computer industry.

Refer to the System Flow Chart shown in Figure 8. The PRIDE® software runs under a "mini" real-time operating system. The operating system is divided into three main parts: the Interrupt Handlers, the Process Controller and the Kernel.

INTERRUPT HANDLERS

The Interrupt Handlers are small routines to service the incoming interrupts. Each interrupt routine will schedule, through the operating system, its appropriate control task (i.e., the zero-crossing interrupt will schedule the frequency measurement task).

PROCESS CONTROLLER

The Controller's main purpose is to process data passed to it from the interrupt handlers or from other tasks. The controller can be broken down into four tasks:

1. Relay control
2. Input conditioning and processing
3. Timers and counters
4. Self-Tests

These tasks each have a priority assigned to them by the operating system according to their importance to overall system flow.

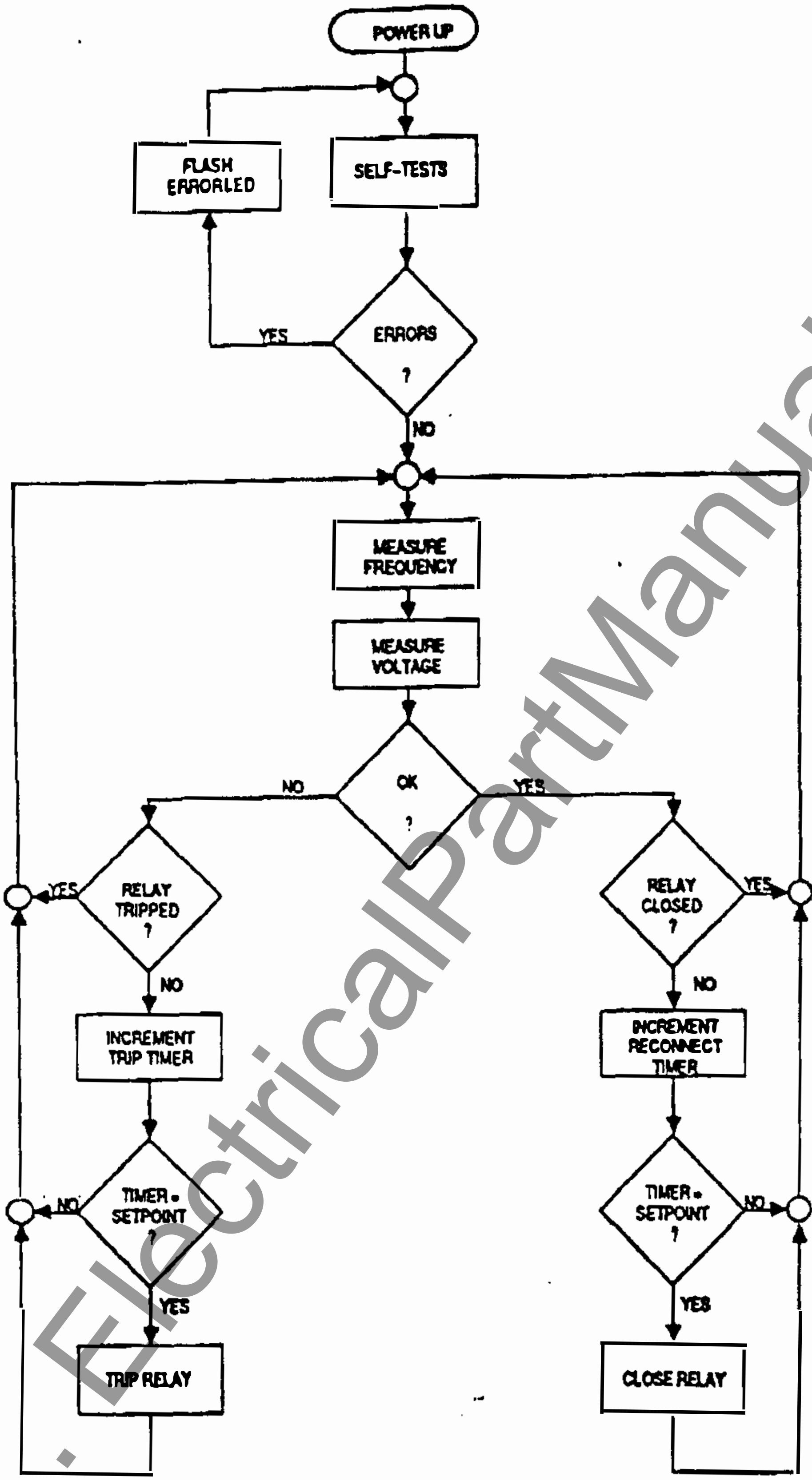


FIGURE 8 System Flow Chart

Relay Control

The Relay Control controls the state of the output relays.

Input Conditioning and Processing

This process is the largest and most complicated of those listed. The actual correlation and computation of input data and the decisions on whether a given measurement is within the setpoint range is accomplished here. This capability for high-speed processing and ability to dynamically change the weight of input conditions is one justification for the incorporation of the microprocessor.

Timers and Counters

This process increments the various timers for voltage, frequency and reconnect, and makes the time-out decisions based on setpoint values.

Self-Tests

On Power Up, the M-0296 will run through a series of Self-Tests to determine if the hardware and software will function properly when brought on-line.

The M-0296 will also perform tests on a low-priority basis in its idle time. If no other tasks are pending, the Self-Test task will continuously run. Failures of any of these tests will result in the output relays reverting to the state specified by the customer for the Output Relay Configuration. A front panel LED will flash indicating an error condition. The Self-Test errors will be described in more detail in the MAINTENANCE section.

KERNEL

The nucleus of the operating system is the Kernel. The Kernel is composed of two parts:

1. The Scheduler
2. The Dispatcher

Scheduler

The Scheduler is flagged from an interrupt driver that is waiting for a task to be performed. Status bits are set by the scheduler to indicate that a task is pending, and then control is returned to the running task. Each task, when started, will run until completion, except the Self-Test task which can be unconditionally preempted.

Dispatcher

When a task is completed, control returns to the Dispatcher, where it picks up a vector to the pending task with the highest priority.

The Self-Test task is the lowest priority and is also permanently pending. Therefore, if the system is not busy, the M-0296 is constantly checking itself.

Because each task is scheduled on a cycle-by-cycle basis, the operating system can be considered to be operating in real-time.

▲ **CAUTION: Do not swap the M-0298 Memory Board or the M-0397 EE PROM Board between PRIDE® models with suffix "A" and "B" and those with suffix "C" (i.e., between M-0296B and M-0296C) or between M-0296C units with serial numbers below 0800 and those with 0800 and above, since this will cause them to misoperate. Refer to the DESIGN CHANGES section of this manual for an explanation of the differences.**

ELECTRICAL DESCRIPTION

The Block Diagram for the M-0296 is shown in Figure 9. The following discussion describes the basic operation of the circuitry.

INPUTS

Power is applied to the PRIDE via rear terminals TB1-3 and TB1-4. The PRIDE can be powered from either ac or dc sources as described below. The Phase potential inputs (TB1-5 through TB1-10) are used only for measurement purposes and draw only a small burden. However, in many cases, the ac power input will be connected to one of the Phase potential inputs, due to the lack of a separate ac power source.

Ac Supply

The Ac Supply PRIDE Units operate from a 120 V ac source. If this is unavailable, the Dc Supply, described below, may be ordered for the PRIDE.

Dc Supply

The Dc Supply mounts in the bottom compartment of the PRIDE (see Figures 11 and 21). Three nominal dc voltage options are available: 125 V dc, 48 V dc or 24 V dc. The PRIDE will operate from approximately 65% of the nominal voltage to 128% of the nominal voltage (i.e., 80 to 160 V dc for the 125 V dc option). Operation from 250 V dc is possible, but requires an external M-0319 Dropping Regulator to provide 125 V dc nominal input voltage to the PRIDE. The M-0296 should be ordered for 125 V dc operation, and the M-0319 is ordered separately. The M-0319 is a resistor-zener diode regulating device used to produce 125 V dc power from a 250 V dc battery source.

POWER SUPPLY

The Power Supply provides the voltages necessary for operation of the digital and analog circuits. A Power Loss Detector is incorporated to warn if the the power supply fails. The Power Loss Detector feature is described in detail below.

Power Loss Detector

When the power supply fails, the input power is lost, or the input power fuse blows, the Power Loss Detector will:

1. Reset the microprocessor.

2. De-energize the K1 Close and K2 Trip output relays. This will be the Trip State in the Standard Relay Configuration and an undefined state (neither Trip nor Close) in the Alternate or Pulse Relay Configuration.

3. Turn off the front panel POWER OK LED.

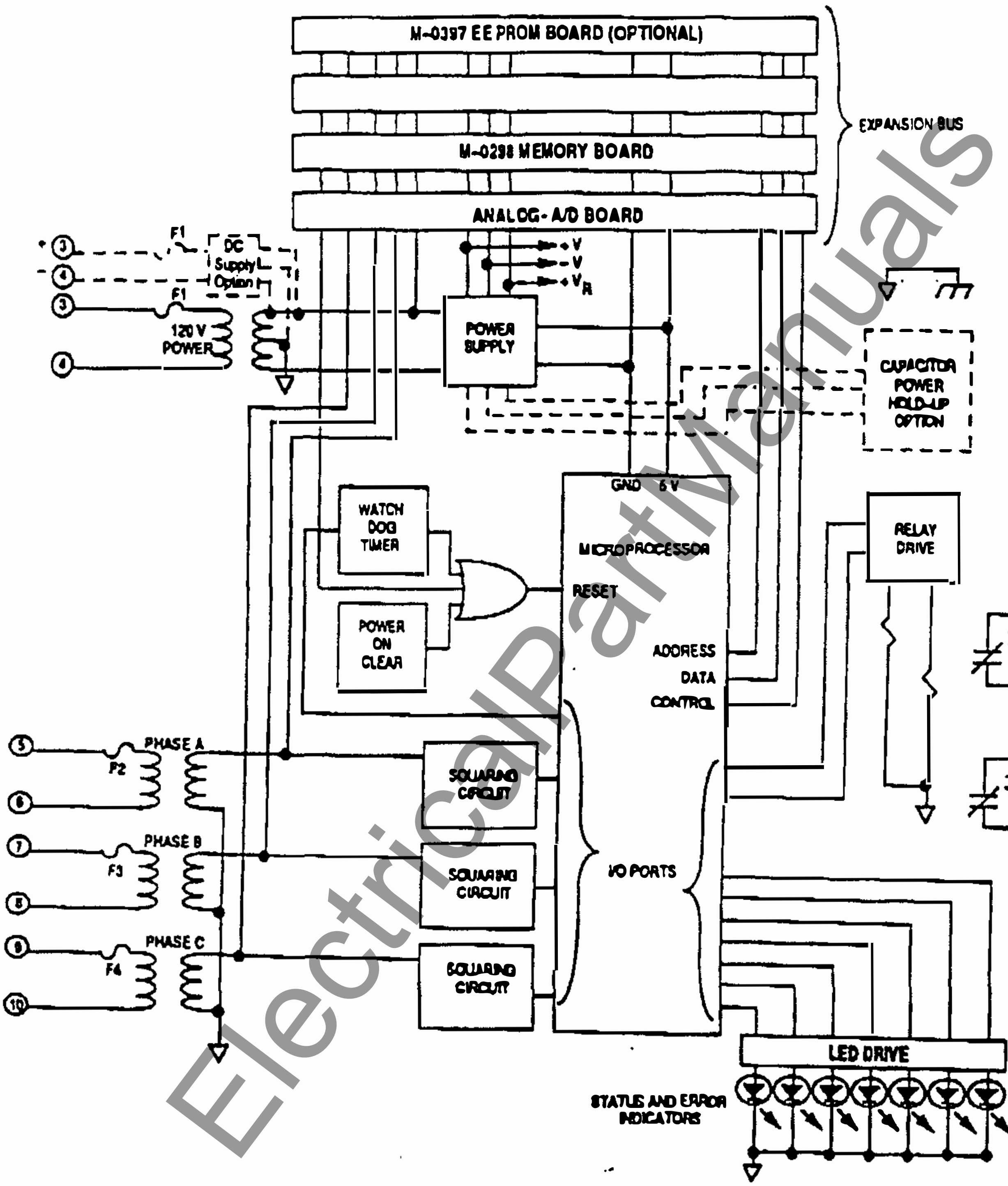


FIGURE 9 Block Diagram

The time delay between when the Power Loss Detector senses a loss and when the K1 and K2 output relays are de-energized is shown in Figure 10. The data was taken by connecting the power input to the Phase A input of the M-0296. The Phase A input was dropped from 120 V ac to levels per the graph, and the time delay for tripping was measured. When the input dropped below approximately 75 V ac, the PRIDE® trip time dropped to 0.25 sec. This is the level where the internal power supply voltage is below its minimum operating level and the Power Loss Detector resets the PRIDE. Therefore, if the input power drops to this level, the PRIDE may trip faster than the programmed time (3 sec in this case).

If this feature is not desirable, the Capacitor Power Hold-Up Option, described below, is available for the PRIDE.

CAPACITOR POWER HOLD-UP OPTION (Ac Supply PRIDE Only)

The PRIDE is designed to operate over a wide range of power supply voltages and waveshapes. The Capacitor Power Hold-Up Option is available if an Ac Supply PRIDE is required to ride through (no tripping) a loss of input power for up to 3 sec. The circuit board, which mounts in the bottom compartment of the PRIDE, provides energy storage so that the PRIDE Unit can continue to operate for up to 3 sec even if the input power source fails. In cases where delayed tripping is required, the PRIDE will time out and delay tripping for up to 3 sec maximum. When using the Inverse Time Delay Option for undervoltage tripping, the PRIDE will continue to calculate the time delays shown in Figures 2 and 3.

■ NOTE: If the M-0297/M-0397 Field Adjustment Unit is mounted in the PRIDE, the power switch on the M-0297 PRIDE Control Unit should be kept in the OFF position unless the Field Adjustment Unit is in use. With the M-0297 power switch in the ON position, the unit will not operate for three seconds after a power interruption.

WATCHDOG TIMER

The Watchdog Timer performs the function of overlooking the program flow of the microprocessor. The watchdog will reset the microprocessor back to an orderly start-up sequence if the program flow is upset or if the software does not perform an operation within the allotted time period. The microprocessor will periodically update or "refresh" the watchdog to keep it out of a reset condition.

POWER ON CLEAR

The Power On Clear block is an RC (Resistor Capacitor) circuit which ensures that a proper Power Up sequence has been accomplished when power is first applied to the unit.

SQUARING CIRCUIT

The Squaring Circuit converts the sinusoidal inputs to square waves. The microprocessor can use these inputs to determine the period (and thus frequency) of the ac input. These waveforms are also used to detect proper phase sequence.

LED and RELAY DRIVE

Because of the microprocessor's low current-sourcing capability, added drive is needed for powering the LED indicators and relays.

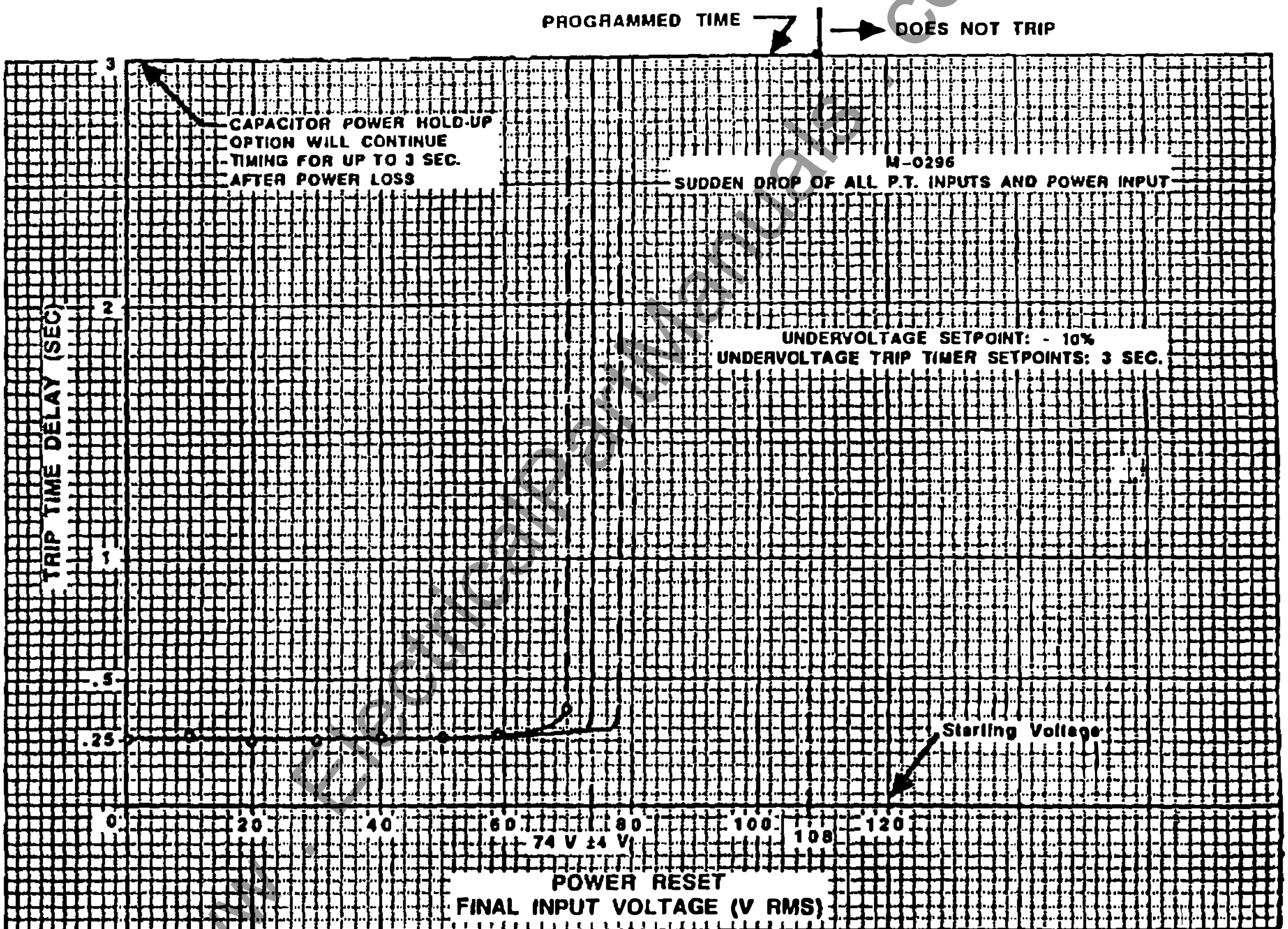


FIGURE 10 Power Loss Time Delay

STATUS and ERROR INDICATORS

All LEDs will remain off when conditions are within specified limits and will light when an over- or under-limit condition occurs. In addition, the PRIDE® Unit has a self-checking feature that will indicate errors by flashing the LEDs. The Self-Test feature will automatically reset and re-test to assure that the error condition is still present. Refer to the **MAINTENANCE** section for further details.

MICROPROCESSOR and ROM

The microprocessor gathers all the external inputs, calculates and processes the data, drives the status indicators and energizes the relays. The microprocessor contains various on-chip functions for frequency measurement and time delay synchronization.

The ROM (Read Only Memory) Memory Board M-0298 contains the program for the microprocessor. The ROM also stores the setpoints programmed at the time of manufacture. The M-0297/M-0397 Field Adjustment Unit can be added to allow programming different setpoints. Refer to the **ADJUSTMENT** section for further details.

> ▲ CAUTION: The ROM is of the ultraviolet erasable type and can be erased if the protective tab is removed from the window and the window is exposed to ultraviolet light.

EXPANSION BUS

All PRIDE Units contain an Expansion Bus for future options. Expansion cards can be plugged into the bus to add new capabilities. Software changes can be accomplished by replacing the M-0298 Memory Board in the Expansion Bus with an updated version.

ANALOG-A/D

The Over- and Undervoltage detection is done in software using the Analog-A/D Converter Board in the Expansion Bus, as shown in Figure 10. Addition of the M-0297/M-0397 Field Adjustment Unit allows the user to change the voltage setpoints as well as the frequency and time delay setpoints.

A dip switch on the Analog-A/D Board, called the Function Disable Switch, allows the user to disable the Voltage Unbalance and Phase Sequence checking functions. This can be useful in testing, since the Phase Sequence function can be disabled and all P.T.s strapped together and tied to a single-phase source.

> ■ NOTE: Any function programmed Disabled on the Analog-A/D card will override any other function enable in the system (e.g., the M-0290/M-0296 Function Enable Byte that is programmed using the M-0297/M-0397). Refer to the FUNCTION ENABLE section for further information.

Three separate circuits are used to convert the ac inputs, for each of the three phases, to square waves for timing measurements. Phase A is used to measure the frequency. The relative timing between Phases A, B and C is used to determine if the A-B-C phase rotation is correct.

MECHANICAL

The PRIDE® packaging was designed for maximum protection of the electronic components from the electrical and natural environment. The steel box is compartmentalized as shown in Figure 11. The inputs and outputs enter the unit at the bottom in the Power Input compartment where the output relays and transformers are mounted. This compartment contains no components that are sensitive to voltage transients or electromagnetic interference (EMI).

The transient suppression required to meet the ANSI Surge Withstand Capability and Fast Transient SWC Test is also located in the Power Input section. The power and potential transformers in this compartment convert the 120 V ac inputs to the lower levels used by the PRIDE. The signals from the input section pass through EMI filters in an internal bulkhead before entering the Power Supply and Processor/Logic sections.

The EMI filters serve a dual purpose. The external interference on the power and potential inputs is prevented from entering the sensitive circuit area. Also, the inherent noise generated by the microprocessor and switching regulator is prevented from leaving the relay and interfering with other equipment.

> ▲ CAUTION: Do not apply any form of test equipment to circuits within the protected portion of the box. In changing any cards within this box, remove all external voltages. Keep one hand on the case to discharge static electricity before touching any of the cards.

TEST BLOCKS

Most utilities have standardized on one of many different test blocks, G.E., Westinghouse and States being the most common. Therefore, Beckwith Electric has not supplied a test block on the PRIDE Unit, thus enabling the user to incorporate his standard test block. This must be added external to the PRIDE Unit.

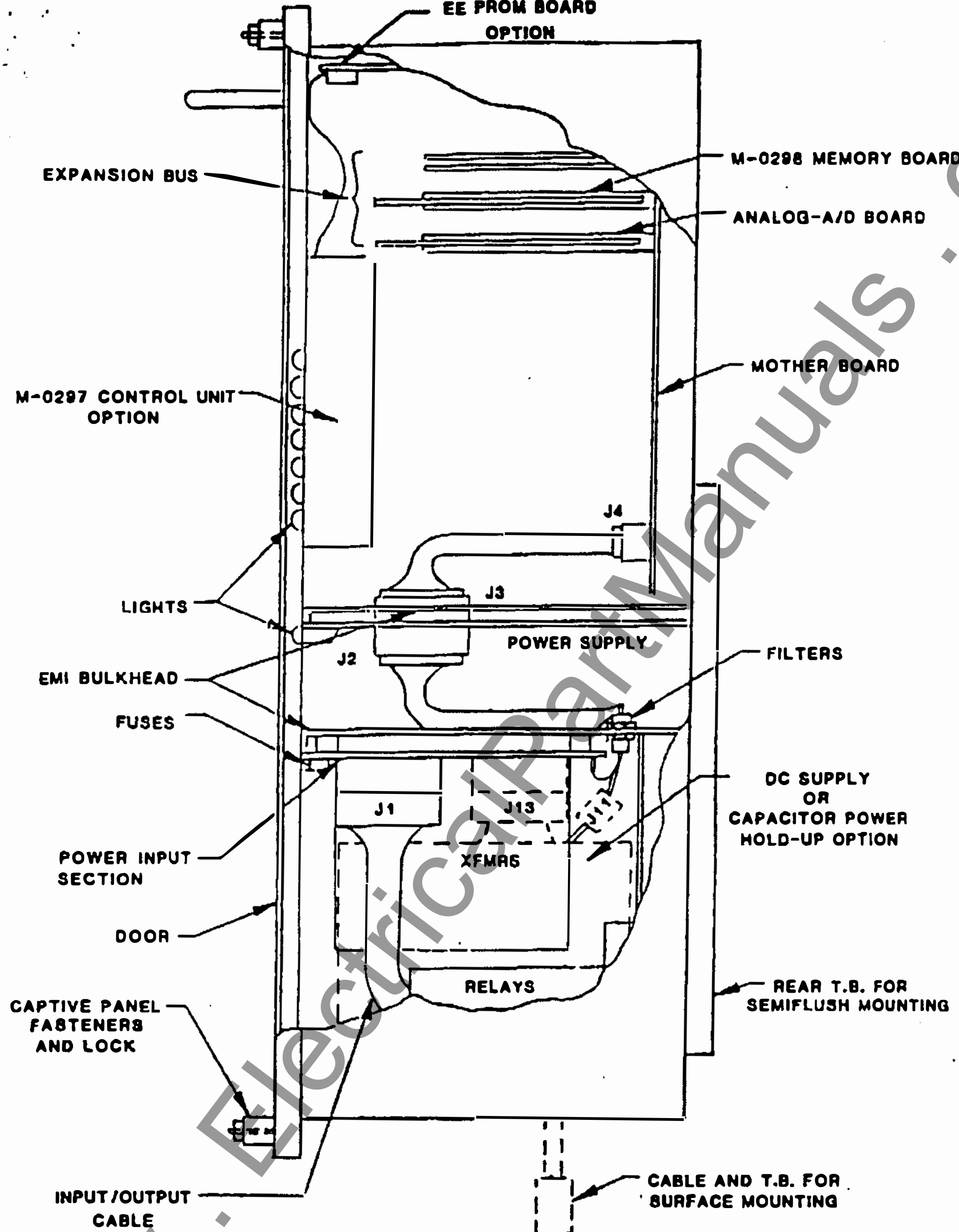


FIGURE 11 Mechanical Configuration

INSTALLATION

▲ **CAUTION: Before installing the PRIDE®, verify that the settings required for the various functions are correct by checking the settings sticker mounted on the inside surface of the unit.**

The PRIDE can be surface mounted or semiflush mounted as shown in Figures 13 and 14. Many small generator applications will use a weather-proof box containing the PRIDE, manual disconnect and a contactor for the interconnection relaying. In these systems, the relay will be surface mounted. Other systems will require semiflush mounting using a rectangular cutout in a relaying panel or swinging door. Refer to Figure 12 for mounting and outline dimensions and Figure 14 for hole drill and cutout dimensions for semiflush mounting.

Because the semiflush mounting nut is located on the inside lip of the relay box and under the front cover, care should be taken when choosing a mounting screw. Four #10-32 screws are required. Refer to Figure 12 for choosing the length of the mounting screws for semiflush mounting. The length of the screw should not exceed 1/4" from the back side of the mounting lip. The total length should be 1/4" plus the thickness of the panel.

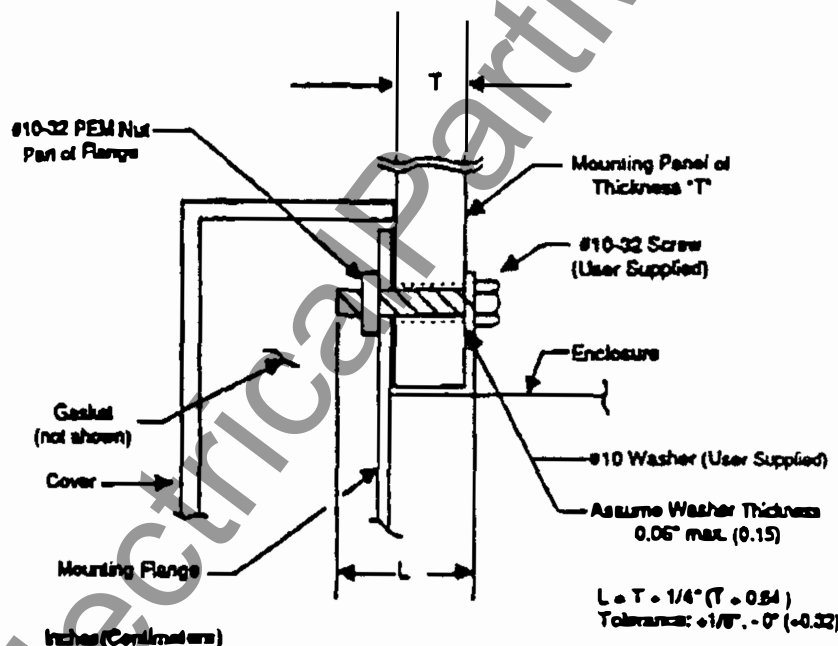


FIGURE 12 Semiflush Mounting Screw

The external wiring connections to the PRIDE Unit are made to a 12-position terminal block that is mounted on the rear of the PRIDE when a semiflush mount unit is ordered. If a surface mounted PRIDE is ordered, a 6-inch cable will extend below the unit with the terminal block attached. The terminal block should then be connected to the panel to which the PRIDE Unit is mounted. Both terminal block positions are shown in Figure 13.

A lug is located in the lower left hand corner for case grounding purposes. Number 6 to 14 AWG wire can be used for this ground strap.

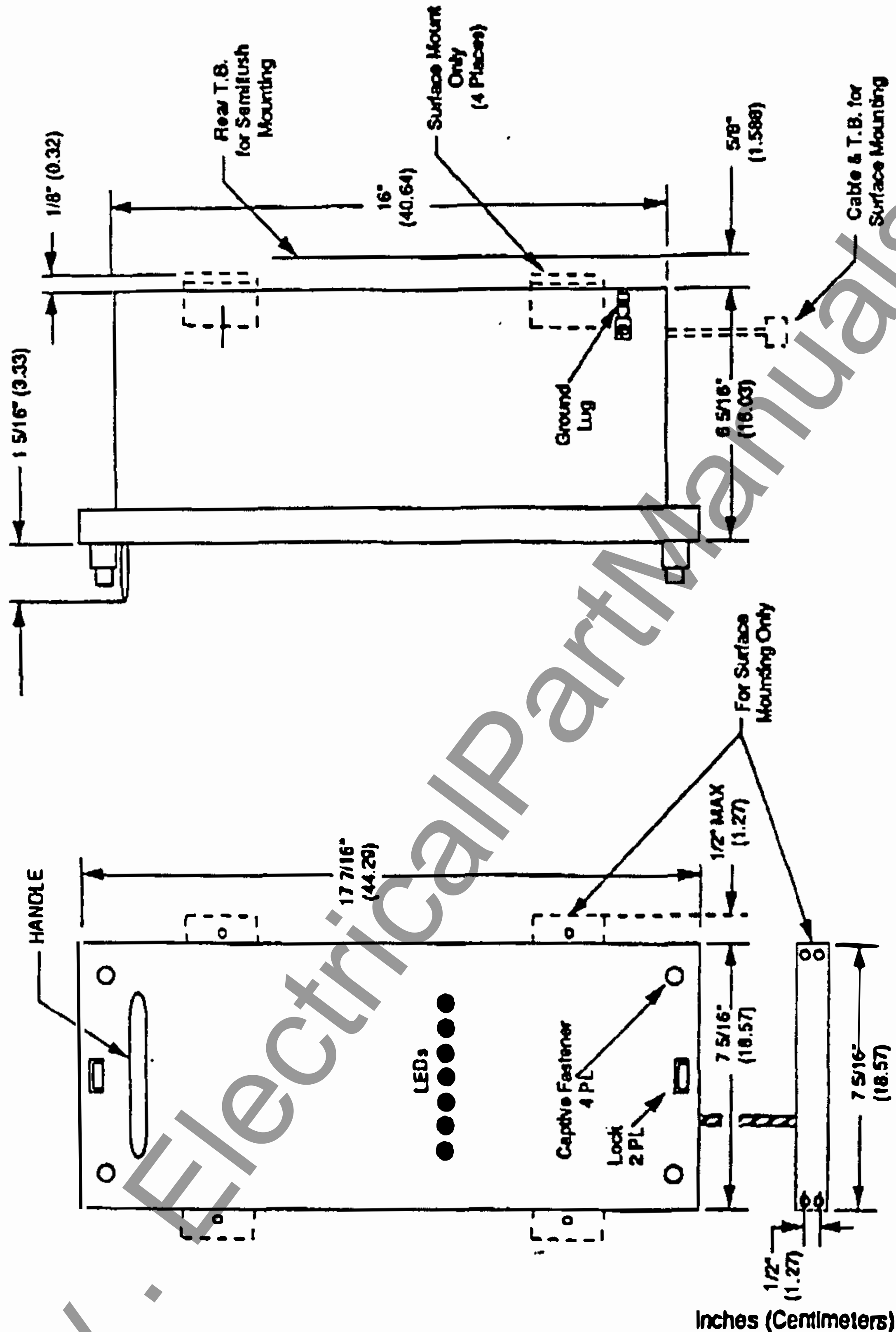


FIGURE 13 Mounting & Outline Dimensions

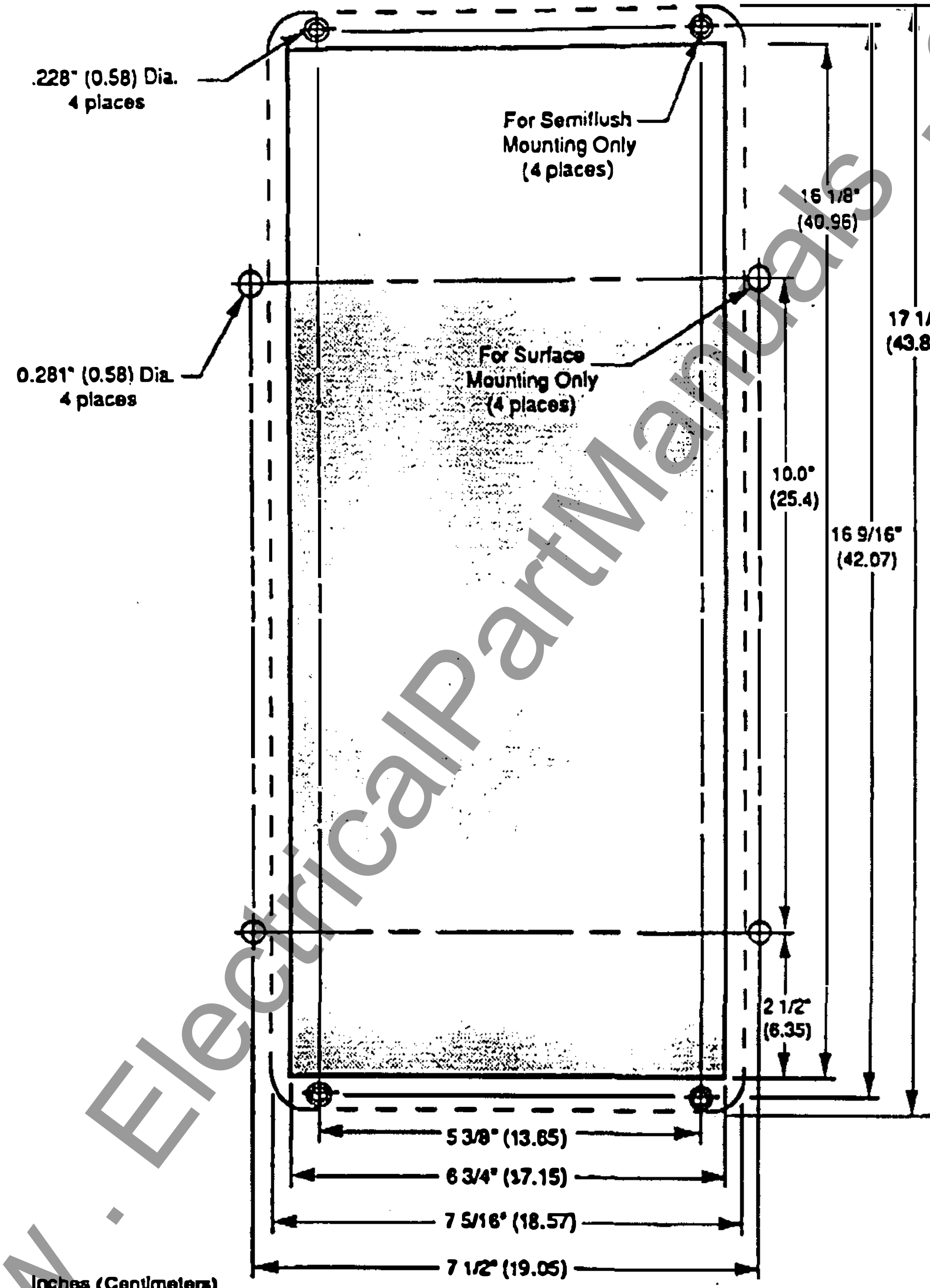


FIGURE 14 Hole Drill and Cutout Dimensions

MOUNTING CONVERSION

Conversion of a PRIDE® Unit from surface to semiflush mounting or vice-versa can be accomplished by the following procedure.

1. Conversion must be done with all external connections to the terminal block removed.
2. Disconnect connector J1 shown in Figure 11 from the Power Input assembly.
3. Remove the input cable from the cable clamp located on the left side wall of the lower compartment. This clamp is not used when the Dc Supply is installed.
4. Remove all wires from the terminal block.
5. Carefully pull the wires through the plastic hole plug and remove the cable harness, with the J1 connector, from the unit.
6. Switch the two plastic hole plugs so that the solid plug covers the hole that is not to be used for the external cable. The hole plug used for the cable feed-through should be mounted as follows.

   Semiflush: Mount the feed-through plug in the hole at the rear of the unit.

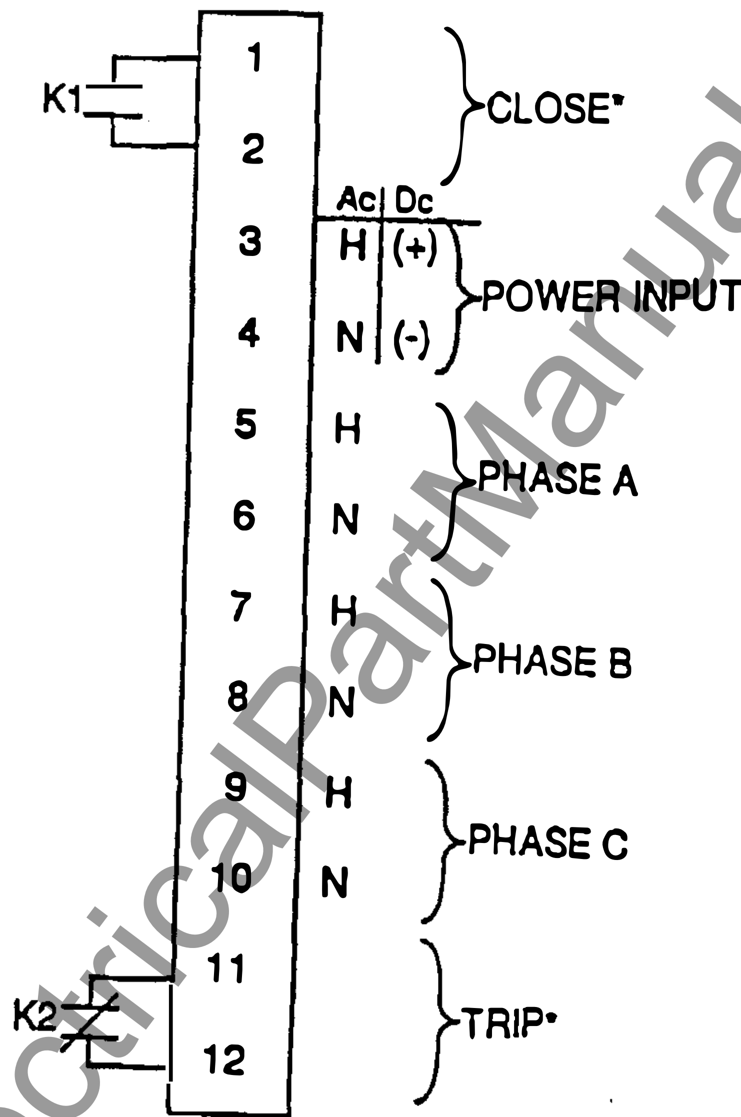
   Surface: Mount the feed-through plug in the hole on the bottom left side of the unit.
7. Carefully push the wiring harness (TB1 end) through the feed-through hole plug from the inside of the PRIDE enclosure. (J1 connector will then be inside the lower compartment.)
8. Re-attach the harness to the cable clamp on the inside of the lower compartment (Ac Supply PRIDE only).
9. Reconnect the harness terminals to the terminal block, being careful to maintain the sequence of wires from 1 to 12.
10. For semiflush mounting, the cable and terminal board should be hanging from the rear of the PRIDE. Mount the terminal board to the four holes on the rear using the four screws and nuts supplied with the unit. Pull all excess cable inside the enclosure and secure with the cable clamp.
11. For surface mounting, mount the terminal block at any convenient location on the mounting surface.
12. Reconnect J1 to the Power Input assembly.

TERMINAL BLOCK CONNECTIONS

The external connections for the M-0296 Three-Phase PRIDE are shown in Figure 15. Figures 16 and 17 show the typical connections for the potential inputs of the M-0296.

OUTPUT CONTACT OPTION

The PRIDE uses a commercially available SPDT relay for the Trip and Close functions. The K1 and K2 relay output contacts are a type "C" arrangement. One side of the "C" contact is wired to the external terminal block. The relay configuration relative to the octal socket is shown in Figure 18. The normally open contact or the normally closed contact can be wired to the external terminal block. One large blue wire is connected to either



■ *NOTE: Relay shown in de-energized state: K1 wired normally open, K2 wired normally closed. Output contacts are not rated for interruption of dc circuits unless external arc suppression is used. Consult the factory when used with dc circuits.

FIGURE 15 External Connections

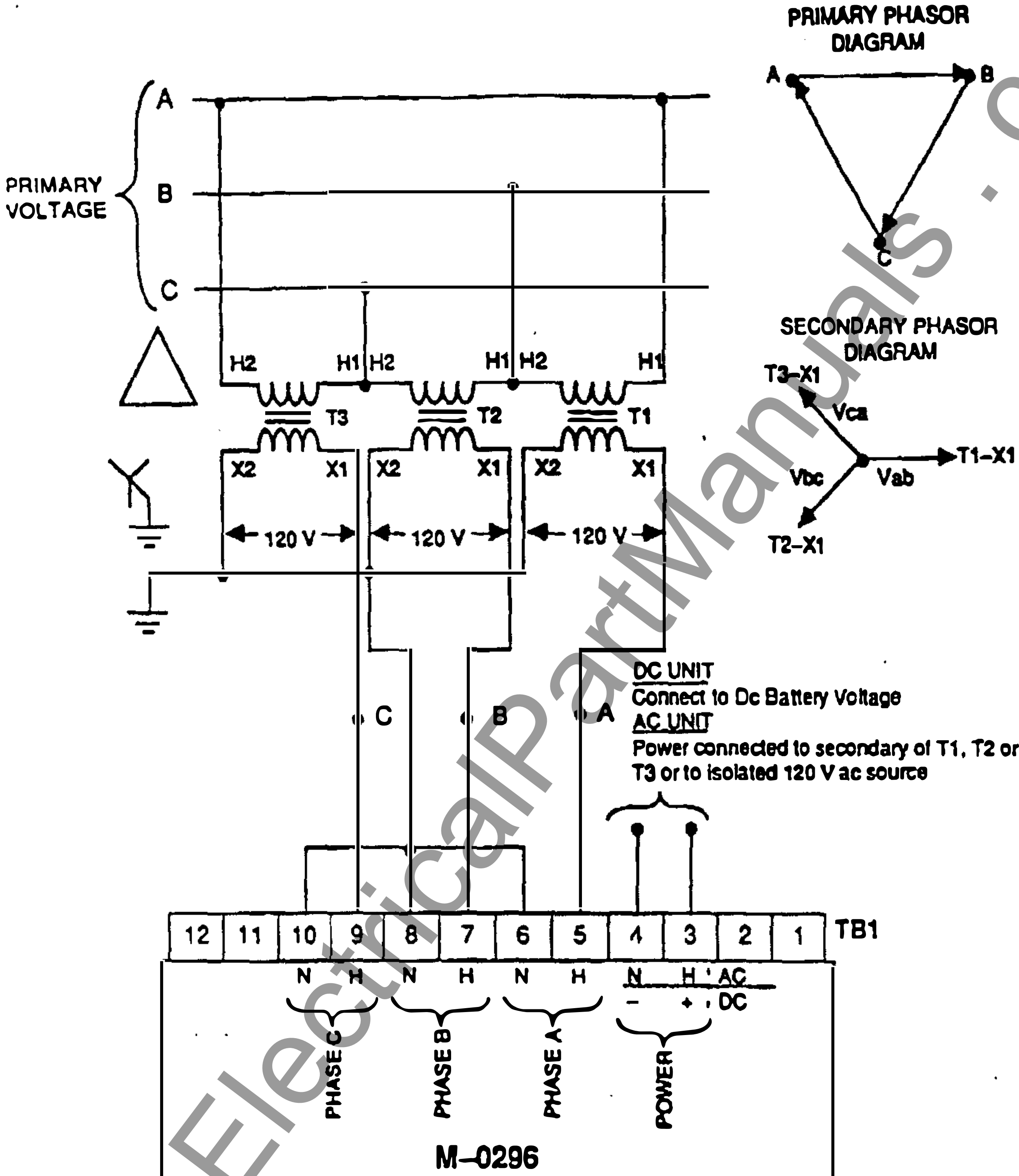


FIGURE 16 Connections to Delta-Wye Potential Transformers

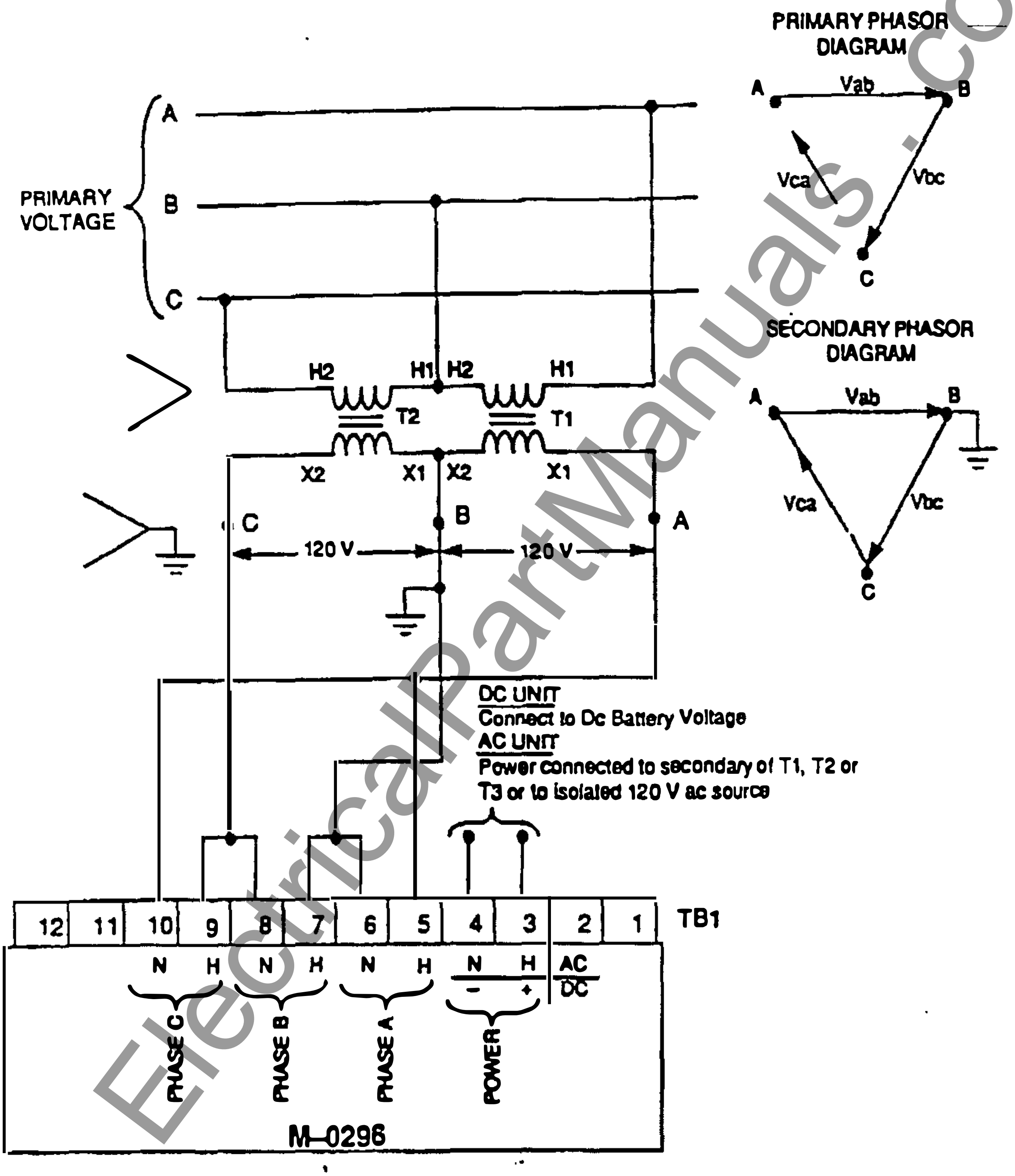


FIGURE 17 Connections to Open Delta-Potential Transformers

terminal 3 or 6 on the bottom of the relay socket. A normally closed output contact is achieved by connecting the wire to terminal 3. A normally open output contact is achieved by connecting the wire to terminal 6. This change can be easily accomplished in the field by switching the wire on terminals 3 or 6.

▲ CAUTION: Before changing the relay contacts or modifying the wiring, all external power must be removed from the PRIDE® Unit. Connector J1 can be used to disconnect the external terminal block only if the current in the output contacts is either externally disconnected or is not flowing through an inductive load that would cause arcing in the J1 connector when the output circuit is opened.

■ NOTE: When J1 is disconnected, the PRIDE output contacts are in an open-circuited condition.

OUTPUT RELAY (K1)

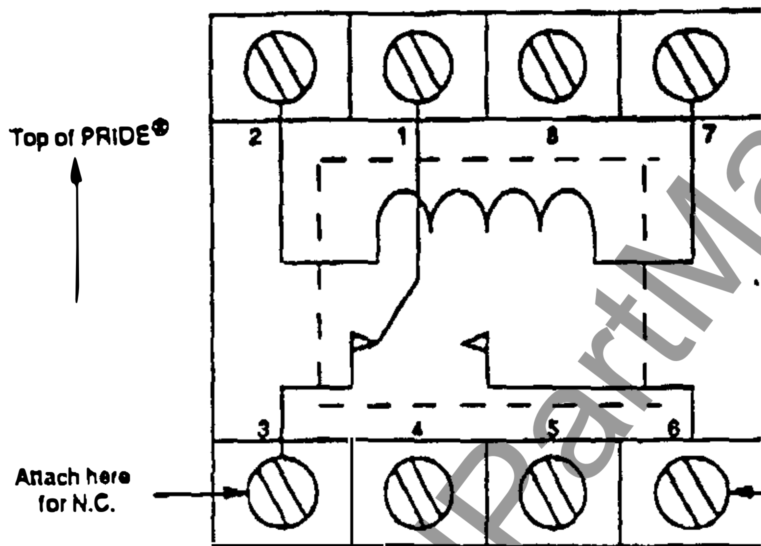


FIGURE 18 Output Contact Option Diagram

ADDITIONAL OUTPUT CONTACTS

Additional output contacts for the PRIDE Unit may be added by changing from an SPDT to a DPDT octal socket relay (i.e., Potter & Brumfield KRP11ADG-12VDC) Beckwith Electric Part # 430-00160. The contact ratings for the additional contact are the same as those given for the normal output contacts. Connections to the relay socket for the normal output contact must be changed from relay socket terminal 3 to terminal 4 for the normally closed contact. Relay socket terminal 3 is used for the normally open output contact. The additional contacts can be accessed at the relay socket terminals:

Normal Contact	Additional Contact Terminal Number
1 - common	8 - common
4 - n.c.	5 - n.c.
3 - n.o.	6 - n.o.

■ NOTE: The wires connecting to the second contact should be routed through the rear or side wiring access hole. External connections to this additional "C" contact must be made directly to the relay socket, bypassing connector J1.

● WARNING: These connections are not disconnected when J1 is unplugged.

CHOOSING LIMIT SETTINGS

When the PRIDE® Unit is purchased, the user should specify the desired limit settings. These settings will be stored in the ROM (Read Only Memory) on the M-0298 Memory Board before the relay is shipped to the user. A record of the settings and serial numbers of the boards will be kept on file by Beckwith Electric. Before installing, assure that the settings listed on the label match those ordered. In many cases there will never be a need to change the settings; however if a change is desired, any of the options listed under the FIELD ADJUSTMENT section may be employed. In choosing the settings desired, the following factors must be taken into consideration.

EFFECT OF LINE PHASE SHIFT ON AN UNDER/OVER FREQUENCY RELAY

Due to variations in the load flow on a line, the phase angle at any point on the line will shift relative to the phase at the substation bus. The transient effect observed on the line at any load point will be a variation in the period of the ac voltage in the cycle during which the loading changes. A frequency relay that is measuring the period of the power line potential will detect the variation in the period and may indicate an over or under frequency condition.

The PRIDE uses a unique digital filter to eliminate the effect of line phase shift. The PRIDE measures the period of each power line cycle and uses the digital filter (Equation 6) to smooth the data before determining if the frequency is within the M-0296 setpoints. The digital filter will produce a transient output for several cycles after a phase shift takes place. However, the Input Loss software will ignore a period that changes more than 273 µs from the previously measured period. This corresponds to an apparent phase shift of 6°. A phase shift of less than 6° will cause a temporary response from the digital filter that could indicate an over or under frequency condition, if the over frequency or under frequency setpoint is within 1 Hz of 60 Hz. Therefore, the minimum time delay settings of Figure 19 are recommended for over frequency and under frequency settings close to 60 Hz.

UNDER AND OVERVOLTAGE SETTINGS

UNDERVOLTAGE

On M-0296 units with an Ac Supply paralleled to a P.T. (without the Capacitor Power Hold-Up Option), it should be noted that the power supply drop-out is approximately 70%. This should be considered when programming the Undervoltage setpoint.

OVERVOLTAGE

The overvoltage reading will saturate at 127% on the M-0296 units. This fact should be considered when calculating Overvoltage Trip times when an inverse time curve (N) is selected.

The Overvoltage setpoint must be at least 1% higher than the undervoltage setpoint, i.e., the minimum voltage band width is 1% total.

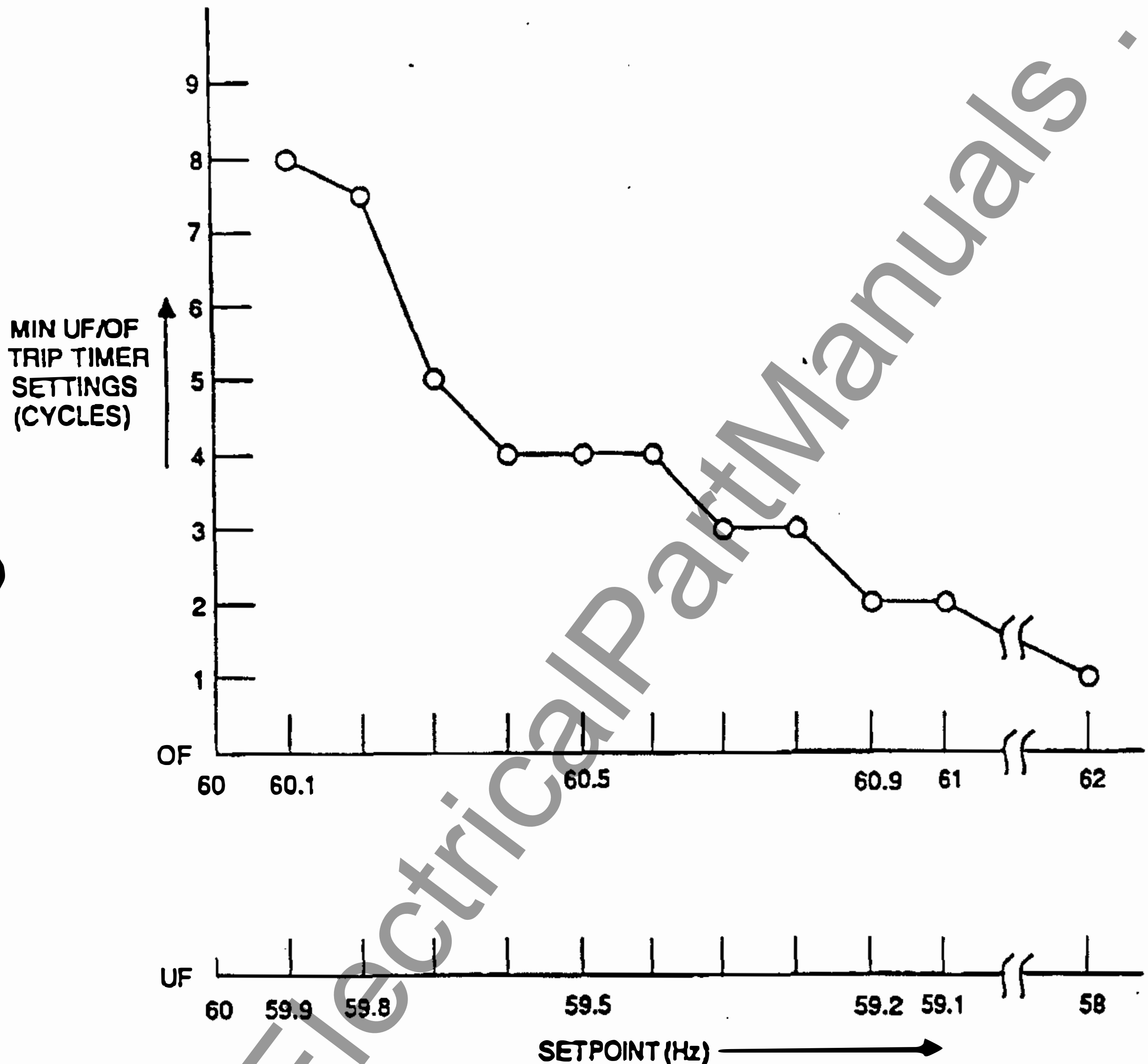


FIGURE 19 Minimum Under/Over Frequency Trip Timer Settings

TIMERS

It is not recommended that the Voltage or Frequency Trip Timers be set less then 3 cycles. This is to prevent short-time transient effects on the measured ac line from causing nuisance trips.

FUNCTION ENABLE

Incorporated in the PRIDE® is the capability to enable or disable certain functions. This can be accomplished in three ways:

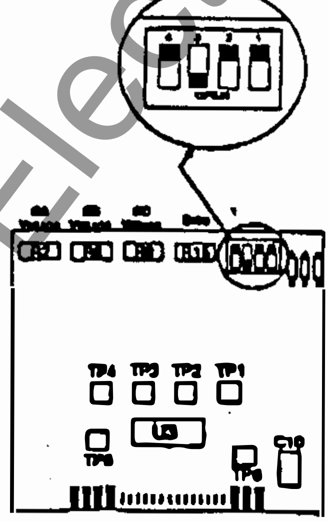
1. Order the functions desired at the time of purchase.
2. Use the optional M-0297/M-0397 Field Adjustment Unit to program the M-0290/M-0296 Function Enable Byte. This procedure is described in the M-0297/M-0397 Instruction Book.
3. Change the appropriate setting on the Function Disable Switch on the Analog-A/D Board.

The Function Disable dip switch is located in the top right-hand corner of the Analog-A/D Board, as shown in Figure 20, which allows the user to disable the Voltage Unbalance and the Phase Sequence functions. With the switch in the Disabled position, the function is disarmed and will not be used by the relay. The appropriate LED will remain off at all times.

■ NOTE: Disabling the function by this means will override a function that has been programmed as enabled in the M-0290/M-0296 Function Enable Byte in the M-0397 (or the default value, if the M-0297/M-0397 option is not being used).

When the switch is in the Not Disabled position, the microprocessor will then look at the Function Enable Byte programmed in the M-0397 (or the default value, if the M-0297/M-0397 option is not being used) to make the enabled or disabled decision.

■ NOTE: The Function Disable dip switch cannot be used to select the Output Relay Configuration. The Standard, Alternate or Pulse Relay Configuration must be selected at the time of purchase of the M-0296, or the M-0297/M-0397 Field Adjustment Unit must be used to select the configuration.



OPEN	CLOSED
1. Not Used 2. Not Used	
VOLTAGE UNBALANCE	
3. Not Disabled	Disabled
PHASE SEQUENCE	
4. Not Disabled	Disabled

FIGURE 20 Analog-A/D Board and Function Enable Switch

FIELD ADJUSTMENT

Two methods of adjusting the PRIDE® settings are available after the unit is installed.

1. Exchange of M-0298 Memory Boards.
2. Use of the optional M-0297/M-0397 Field Adjustment Unit.

EXCHANGE OF MEMORY BOARDS

● **WARNING: Be sure to remove all external voltages before changing the boards. Keep one hand on the case to discharge static electricity before touching any of the boards.**

▲ **CAUTION: Do not swap the M-0298 Memory Board or the M-0397 EE PROM Board between PRIDE models with suffix "A" and "B" and those with suffix "C" (i.e., between M-0296B and M-0296C) or between M-0296C with serial numbers below 0800 and those with 0800 and above, since this will cause them to misoperate. Refer to the DESIGN CHANGES section of this manual for an explanation of the differences.**

When ordering a new Memory Board from Beckwith Electric, specify the new settings required. When the new board is received, remove the old board by carefully sliding it out of its slot (see Figure 11). If you are exchanging Memory Boards, place the old Memory Board in the antistatic bag and shipping carton and return to Beckwith Electric if credit is desired. Install the new board, assuring that the settings specified agree with those listed on the label supplied with the new board. To install the new board, carefully slide the board into the proper slot; the connectors are keyed so that the board cannot be put in incorrectly. Attach the new setpoint label over the old label located on the inside wall of the PRIDE Unit.

FIELD ADJUSTMENT UNIT

The Field Adjustment Unit consists of the M-0297 PRIDE Control Unit and the M-0397 EE PROM Board. The M-0397 is a printed circuit board that is permanently installed in the PRIDE and is used to store the programmable setpoints. The M-0297 is a keyboard and display that can be permanently mounted with the M-0397 or can be temporarily mounted so that the relay settings can be changed. Once the limits have been set on the M-0397, the M-0297 can be unplugged and used to program the settings on other PRIDE Units. The Field Adjustment Unit can also be used to monitor conditions such as line frequency and timer progress, to enable or disable certain functions, as well as interrogating setpoints and trip targets.

■ **NOTE: When ordering the PRIDE Unit with the Field Adjustment Unit, the user must specify a set of default settings that will be used if the M-0397 is later removed from the PRIDE.**

The M-0397 EE Prom Board may be ordered separately to supply Trip Targets. For further details, refer to the M-0297/M-0397 Field Adjustment Unit Instruction Book.

MAINTENANCE

Due to the extremely sophisticated nature of the circuitry in the PRIDE® Units, field repair, other than that listed below, is not recommended. All units are fully calibrated at the factory prior to shipment; there is no need to calibrate a unit prior to initial installation. There are no user calibration points on the PRIDE Units. In the event that a unit does not operate properly, it should be established that the problem is caused by malfunction of a Beckwith Electric unit and not caused by an external fault or wiring error. Once this is assured, the defective circuit board or entire unit should be returned to Beckwith Electric. Pack the unit carefully (in the original carton, if possible), assuring that there is adequate packing material to protect the contents. If a circuit board is being returned, place it in the anti-static bag provided with the original carton and pack it carefully to avoid damage.

■ NOTE: Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the user. The warranty is void if the value of the unit is invoiced to Beckwith Electric at the time of return or if the unit is returned with transportation charges collect.

If under warranty, units will be repaired rapidly and returned at no cost, and with return transportation paid if the fault is found to be due to workmanship or failure of material. If a unit is under warranty and express shipment for return of the repaired unit is requested, shipping charges will be billed at the current rate. If the fault is due to abuse or misuse, or if the unit is out of warranty, a modest charge will be made. Repair can normally be expected to take two weeks, plus shipping time. If faster service is required, it should be requested at the time of return.

■ NOTE: Units returned with only a blown fuse are not covered by warranty and a nominal repair charge will be made for replacement of the fuse. Please check the fuses before returning the M-0296 for repair in order to avoid unnecessary repair changes.

To help in analyzing the problem, a complete description of the malfunction and conditions leading to the failure should be included with the unit.

M-0315 PRIDE TEST ADAPTER

The M-0315 Test Adapter is used to ease the connection of the external test equipment to the PRIDE for test purposes.

The M-0315 Test Adapter is used to functionally test the operation of the M-0290 and M-0296. The M-0315 consists of a phenolic enclosure containing fourteen five-way binding posts and a five-foot extension cable with two polarized plugs that connect to the PRIDE Power Input section. The binding posts are color coded to indicate polarity where it is applicable (the red posts indicate the Hot or Positive side) and labeled to directly correspond to the M-0290 and M-0296 rear terminal block connections.

TROUBLESHOOTING

POWER SUPPLY

If the front panel POWER OK LED is not lit, the following should be checked.

1. Is 120 V ac or correct value dc applied to the input terminal block TB1-3 (HOT/+) to TB1-4 (NEUTRAL/-)?

2. Is the Input/Output Cable properly plugged into the Power Input Section (TB-1 to J1)?

   If the cable or connector appears to be defective, return it to the factory for repair.

   ■ NOTE: The Input/Output Cable is not interchangeable between an M-0290 and an M-0296.

3. Are the fuses installed properly and not blown?

   The PRIDE® Units contain fuses on the power and potential inputs. These fuses are located on the front edge of the printed circuit board at the top of the Power Input Section (see Figure 11 and Figure 21). To check these fuses, remove the power from the unit by disconnecting connector J1. Pull the fuses from their sockets and check their continuity with an ohmmeter. If any fuse is determined to be open-circuited, replace that fuse and recheck the operation of the unit. Spare fuses are taped to the inside of the bottom compartment of the PRIDE. Additional fuses are available from Beckwith Electric. Refer to Table 2 for ordering information.

   ■ NOTE: Units returned with only a blown fuse are not covered by warranty, and a nominal repair charge will be made for replacement of the fuse. Please check the fuses before returning the PRIDE for repair in order to avoid unnecessary repair charges.

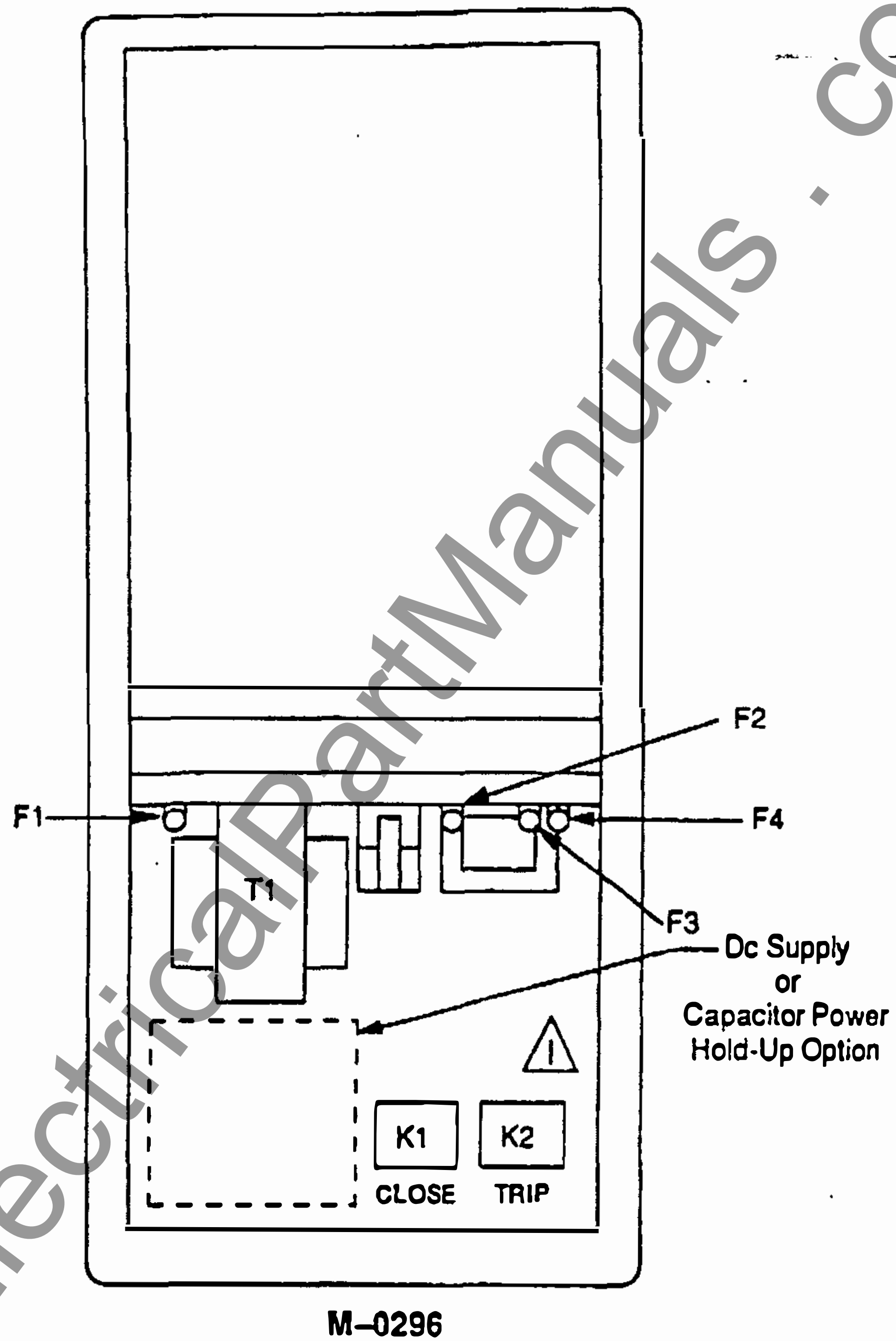
Component	Beckwith Electric Number	Description
F1	420-00719	Plug-in Microfuse, 1 A, Littelfuse 273.001
F2 - F4	420-00725	Plug-in Microfuse, 1/2 A, Littelfuse 273.500

▲ CAUTION: Be careful to replace the fuses only with an identical replacement. Do not replace a 1/2 A fuse with a 1 A fuse or vice-versa.

TABLE 2 Replacement Fuses

If the above procedure has been followed, and the POWER OK LED is still not lit, return the unit to the factory.

If the POWER OK LED is lit, but the unit does not operate, assure that the M-0298 Memory Board is plugged in completely. If the Field Adjustment Unit is being used, be sure that the M-0397 EEPROM Board is plugged in properly.



Spare Fuses are Taped to the inside of the enclosure in this compartment.

FIGURE 21 Location of Input Fuses and Output Relays

OUTPUT RELAYS

The output relays are located at the bottom of the Power Input Section. These are commercially available octal socket relays, and can be removed from the PRIDE® and checked for proper operation. The relays require 12 V dc across the coil to operate.

INTERNAL CABLES

Assure that J3 and J4 Connector Cables are plugged in completely.

SELF-TEST INDICATORS

The LEDs on the front panel are used to indicate Self-Test failures by flashing at approximately 2 cycles per second when an error is detected (refer to Figure 22). The Self-Test errors are described in the following sections.

ROM Failure

Indicates that the external ROM (Read Only Memory) on the M-0298 Memory Board has failed. This can be caused by improper programming of the ROM or a partially erased or defective ROM.

CORRECTIVE PROCEDURE: Assure that the M-0298 Memory Board is properly plugged into the unit. If the light continues to flash, replace the M-0298 board. If this does not correct the problem, return the PRIDE Unit to the factory.

RAM Failure

Indicates that the internal microprocessor RAM (Random Access Memory), external RAM or the M-0397 RAM (if using the Field Adjustment Unit) has failed.

CORRECTIVE PROCEDURE: Assure that the M-0298 (and M-0397 if using the Field Adjustment Unit) boards are properly plugged into the unit. If the light continues to flash, replace the board or return the PRIDE Unit to the factory for repair.

Operating System Failure

This failure mode indicates that the normal processing flow has been upset.

CORRECTIVE PROCEDURE: Assure that the M-0298 (and the M-0397 if using the Field Adjustment Unit) boards are properly plugged into the unit. If the light continues to flash, replace the board or return the unit to the factory.

A/D Failure

Indicates the A/D Converter has failed to complete a conversion in the time allocated by the A/D Watchdog Timer. Improper Analog-A/D Card installed in unit. Refer to the **DESIGN CHANGES** section.

CORRECTIVE PROCEDURE: Make sure the correct Analog-A/D Board is installed for the proper version of software programmed in the Memory Board. If the correct Analog-A/D Board is installed, and the LED continues to flash, replace the Analog-A/D Board. If the LED continues to flash with a new Analog-A/D Board installed, return the entire unit to the factory.

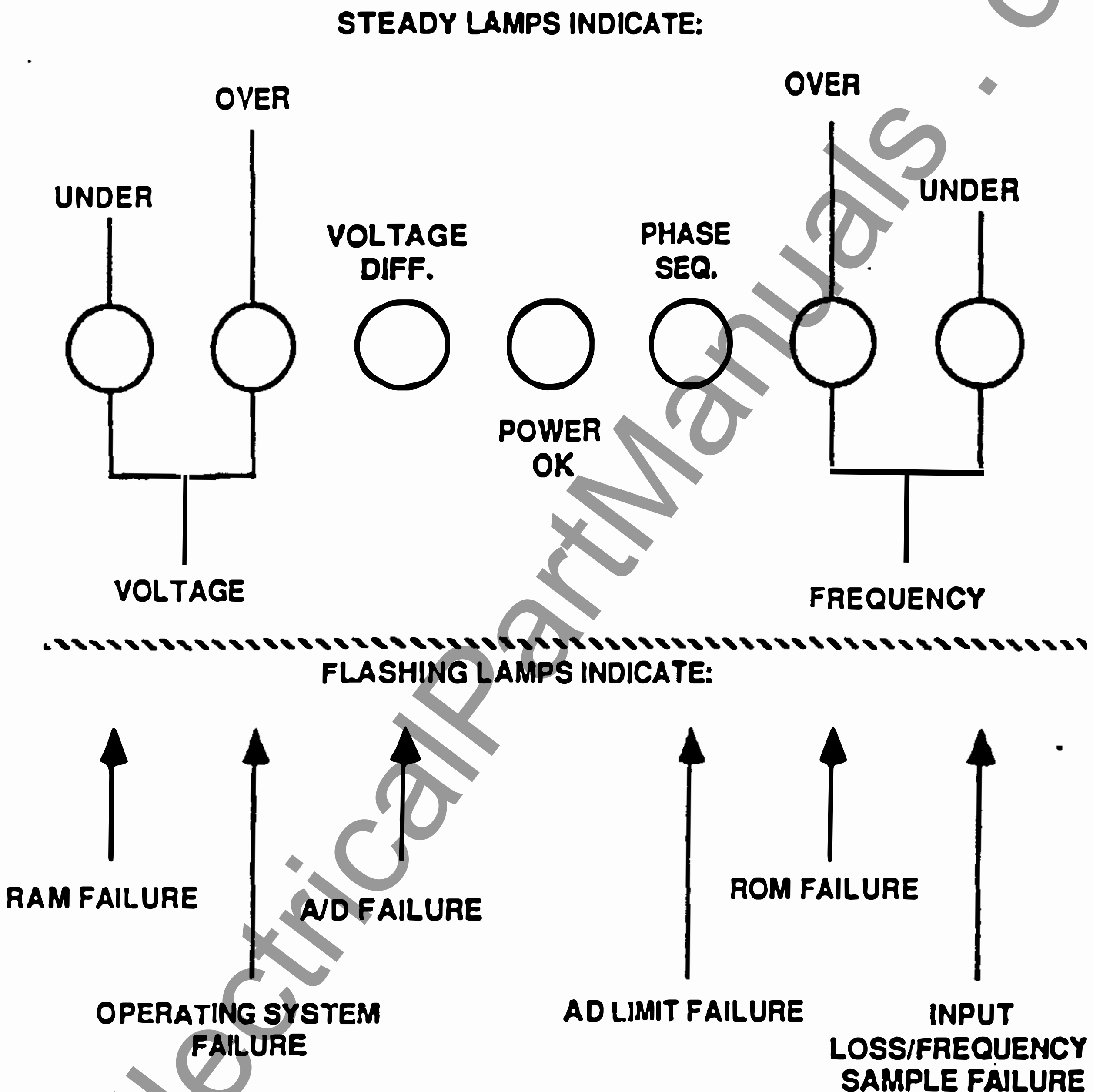


FIGURE 22 Self-Test Error Indicators

/mit Failure

/dicates the A/D Converter has received an erroneous result in the A/D scaling and offset test.

CORRECTIVE PROCEDURE: Replace the Analog-A/D Board. If the LED continues to flash, return the unit to the factory.

Input Loss/Frequency Sample Failure

Signaled by a loss of zero crossings on the frequency measuring input to the microprocessor. Caused by extremely low voltage on the phase A potential input, an unconnected potential input or a grossly out of specification frequency measurement.

CORRECTIVE PROCEDURE: Assure that all potential inputs are properly connected. Check to see if any potential input fuse has blown. If the light continues to flash, return the unit to the factory.

▲CAUTION: Prior to applying power to the unit, double-check all connections to ensure that no wires are pinched or broken and that all the boards are plugged in completely.

FUNCTIONAL TEST PROCEDURE

EQUIPMENT REQUIRED

1. A single-phase power source with frequency range variable from 55 Hz to 65 Hz and an accuracy of ±.005 Hz or better; variable voltage from 60 V rms to 150 V rms with amplitude stability of ±0.25% or better.
2. A digital multimeter Hewlett-Packard 3466A or equivalent.
3. A stopwatch or an accurate timing device.
4. A fixed 120 V, 60 Hz (or 125, 48 or 24 V dc if the Dc Supply Option is installed), 25 W power source for the power supply input.

■ NOTE: The M-0315 PRIDE® Test Adapter can be used to simplify the connections to the M-0296 for testing.

CONNECTION PROCEDURE

1. Connect the fixed 120 V, 60 Hz ac power to TB1-3 (HOT) and TB1-4 (NEUTRAL). If the PRIDE has a Dc Supply, connect dc power to TB1-3 (+) and TB1-4 (-).
2. Be sure that the variable voltage and frequency source is turned off before connecting it to TB1-5 (HOT) and TB1-6 (NEUTRAL); TB1-7 (HOT) and TB1-8 (NEUTRAL); and TB1-9 (HOT) and TB1-10 (NEUTRAL).
3. Disable the Phase Sequence function as described in the FUNCTION ENABLE section. This will allow testing of the M-0296C with a single-phase source.

■ **NOTE:** If the M-0297/M-0397 Field Adjustment Unit is present, the Phase Sequence function can be disabled for test purposes (see the M-0297/M-0397 Instruction Book for details). Alternatively, on M-0296C units with serial numbers 0800 and above, the Function Disable Switch can be used to disable the Phase Sequence function. All three P.T.s can then be tied together and the unit will reconnect after the programmed reconnect time.

INPUT LOSS/FREQUENCY SAMPLE FAILURE SELF-TEST

1. Turn on the power supply. Verify that the **UNDER FREQUENCY LED** blinks five consecutive times, stops for about 1 sec, then repeats. In this Self-Test mode, the LED will continue to blink until the potential input voltages are detected.

2. Turn on the potential input and adjust to 120 V ac, 60 Hz. Skip Step 3 if the LED remains off, indicating that the system is operating correctly.

3. If any LED continues to blink after several seconds, this indicates the M-0296 will not pass the Self-Test mode. Refer to the **SELF-TEST INDICATORS** section, then check wiring, connector orientation and fuses. If, after checking the unit, an LED continues to flash, the unit is defective.

■ **NOTE:** If the M-0297/M-0397 Field Adjustment Unit is present, various setpoints and timer delay values (especially the Reconnect Timer) can be changed to speed up testing. In addition, frequency and voltage values, and timer progress can be monitored as part of a test procedure. Refer to the M-0297/M-0397 Instruction Book for further details.

UNDER/OVER FREQUENCY DETECTION

1. Slowly decrease the frequency of the potential input from 60 Hz until the **UNDER FREQUENCY LED** turns on.

2. The measured frequency level should be equal to the Under Frequency setpoint ±0.02 Hz.

3. Return the input frequency to 60 Hz.

4. Slowly increase the input frequency from 60 Hz until the **OVER FREQUENCY LED** turns on.

5. The measured frequency level should be equal to the Over Frequency setpoint ±0.02 Hz.

6. Return the input frequency to 60 Hz.

UNDER/OVERVOLTAGE DETECTION

1. Slowly decrease the input voltage from 120 V until the **UNDERVOLTAGE LED** turns on.

2. The measured voltage level should be equal to the Undervoltage setpoint ±1%.

3. Return the input voltage to 120 V.

4. Slowly increase the input voltage until the **OVERVOLTAGE LED** turns on.

5. The measured voltage level should be equal to the Undervoltage setpoint ±1%.

6. Return the input voltage to 120 V.

MAXIMUM VOLTAGE UNBALANCE DETECTION

■ NOTE: The Voltage Unbalance and Phase Sequence functions can be disabled by changing the position of the Function Disable Switch located on the Analog-A/D Board. Refer to the FUNCTION ENABLE section for further details.

1. Since all three inputs are connected in parallel to the potential, the VOLTAGE DIFFERENCE LED should be off.
2. Turn off the variable and fixed power sources, and disconnect one of the potential inputs by removing the HOT wire.
3. Reapply power to the unit. The UNDERVOLTAGE and the VOLTAGE DIFFERENCE LEDs should turn on.
4. To test the Voltage Difference setpoint, remove the power sources from the M-0296 and connect two of the potential inputs in parallel with the 120 V ac power input. The variable source is then used for the third potential input.
5. Reapply power, then raise and lower the variable source above and below the level of the 120 V power source and record the voltage levels where the VOLTAGE DIFFERENCE LED turns on.
6. The difference of the recorded voltages should be equal to the Maximum Voltage Unbalance setpoint ±2% of the input.
7. Remove power from the unit and reconnect the potential inputs.
8. Return the voltage to 120 V.

RECONNECT TIMER

1. Decrease the frequency until the UNDER FREQUENCY LED turns on, and the Close and Trip relays change state.
2. Slowly return the frequency to within the Under Frequency limit setting, and begin timing when all LEDs turn off. Stop timing when the relays again change state.
3. The measured reconnect time delay should be ±0.5 second or ±1% of the calculated Total Time Delay, whichever is greater.

FIXED TRIP TIMERS

■ NOTE: Both the Fixed and Inverse Trip Timers can be tested using a stopwatch per the following procedure if the time delay settings are at least 1 sec. If the time delays are faster than 1 sec, a timer is required that is initiated by the change in the input condition and is stopped by the PRIDE® Trip contact.

Over Frequency Trip Timer

1. Quickly raise the frequency from 60 Hz to approximately 0.5 Hz above the Over Frequency setpoint.

2. The measured trip time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Under Frequency Trip Timer

1. Quickly lower the frequency from 60 Hz to approximately 0.5 Hz below the Under Frequency setpoint.
2. The measured trip time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Overvoltage Trip Timer

1. Quickly raise the input voltage from 120 V to about 10% higher than the Overvoltage setpoint.
2. The measured trip time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Undervoltage Trip Timer

1. Return the input to 120 V and wait for the Close relay to change state.
2. Lower the input to about 10% below the Undervoltage setpoint.
3. The measured trip time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Voltage Unbalance Trip Timer

1. Remove the fixed and variable power sources from the M-0296 and connect two of the three potential inputs in parallel with the 120 V ac power input; connect the variable ac source to the third potential input.
2. Quickly raise the variable input voltage to approximately 10% higher than the Maximum Voltage Unbalance Trip setpoint.
3. The measured time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.
4. Return the variable source to 120 V and wait for the relays to change state.
5. Lower the variable source voltage to about 10% lower than the Maximum Voltage Unbalance Trip setpoint.
6. The measured time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

INVERSE TRIP TIMERS

Undervoltage Trip Timer

1. Return the input to 120 V and wait for the relays to change state. Refer to Figure 2 or 3 and select the curve for N_c = X (X = the curve number preprogrammed with the unit).
2. Quickly lower the input to where the trip time should be 100% of the specified time delay setting (T_{set}) and measure the time delay.

3. Repeat Steps 1 and 2, as required, for other points on the time curve.

4. The measured time delays should be within ±1 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Overvoltage Trip Timer

1. Return the input to 120V and wait for the relays to change state. Refer to Figure 4 or 5 and select the curve for N_o = X (X = the curve number preprogrammed with the unit).

2. Quickly raise the input voltage to where the trip time should be 100% of the specified trip timer setting (T_{ov}) and measure the time delay.

3. Repeat Steps 1 and 2, as required, for other points on the time curve.

4. The measured time delays should be within ±1 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

Voltage Unbalance Trip Timer

■ NOTE: Figures 2 and 3 are also used to determine the shape of the Voltage Unbalance Inverse Trip Timer curve. The horizontal axis is "$\Delta V - \Delta V_s$ (As % of 120 V)" and the vertical axis is "Voltage Unbalance Time Delay (As % of T_s)".

1. Remove the fixed and variable power source from the M-0296 and connect two of the three potential inputs in parallel with the 120V ac power input; connect the variable ac source to the third potential input.

2. Adjust the variable input voltage to equal the fixed source voltage and wait for the Close relay to change state. Select the curve with N_s = X (X= the curve number preprogrammed with the unit) from Figure 2 or 3.

3. Quickly lower the variable voltage input to where the trip time should be 100% of the specified trip timer setting (T_s) and measure the time delay.

4. Repeat Steps 2 and 3, as required, for other points on the time curve.

5. The measured time delays should be ±1 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

PHASE SEQUENCE DETECTION

The Phase Sequence function is permissive for reconnection only. The PHASE SEQUENCE LED will show the Phase Sequence status if this function is enabled; if disabled, this LED will remain off and Phase Sequence will not impede reconnection.

1. Remove the power and potential inputs from the M-0296.

2. Disable the Phase Sequence function with the Function Disable Switch, located on the Analog-A/D Board. Verify that the M-0296 unit reconnects when the power and potential inputs are applied.

3. Remove the power and potential inputs from the M-0296.

4. Place the Phase Sequence Function Disable Switch on the Analog-A/D card to the Not Disabled position.

5. If the Phase Sequence function is enabled, the unit should not reconnect when the power and potential inputs are reapplied. The PHASE SEQUENCE LED should be lit.

> ■ NOTE: Further tests can be performed on the Phase Sequence function if a three-phase source is available. The unit should reconnect if the Phase Sequence function is Enabled in the M-0290/M-0296 Function Enable Byte, the Function Disable Switch on the Analog-A/D Board is in the Not Disabled position, and the proper three-phase potential is applied in the proper A-B-C rotation.

M-0297/M-0397 FIELD ADJUSTMENT UNIT INSTALLED IN THE M-0296

M-0397 TRIP TARGETS

1. Disable the Phase Sequence function, if necessary.

2. Push the RESET TARGET pushbutton, located at the top right-hand corner of the M-0296, to erase the previous trip targets that were stored in the nonvolatile RAM (EE PROM) memory.

3. Increase the input voltage level until the OVERVOLTAGE LED turns on and wait for the Trip relay to change state.

4. Lower the voltage until the OVERVOLTAGE LED turns off and the Trip relay again changes state.

5. Push the TARGET pushbutton; the OVERVOLTAGE LED should turn on. Release the pushbutton and the LED should turn off again.

6. Drop the input frequency until the UNDER FREQUENCY LED turns on and wait for the Trip relay to change state.

7. Return the frequency to 60 Hz and push the TARGET button again. The UNDER FREQUENCY LED should turn on this time and the OVERVOLTAGE LED should stay off.

8. Release the TARGET pushbutton; both LEDs should be off.

9. Push and release the RESET TARGET button, then push the TARGET button again. All LEDs should remain off, signifying that the previous trip status has been erased.

M-0297 PRIDE CONTROL UNIT

1. Be sure that the cable on the M-0297 PRIDE® Control Unit is properly installed in the socket on the M-0397 board. If the Control Unit is not plugged in, turn the power switch to OFF before connecting the unit.

2. Refer to Table 3 "Valid Show Status Function Numbers" in the M-0297/M-0397 Instruction Book and check each function.

3. Refer to Table 2 "Valid Read Setpoint Function Numbers" and check the ROM Default Setpoints to verify that they match those recorded on the label in the bottom compartment of the M-0296. Record the number of RAM Store Cycles (Function Number 39).

4. Using Table 1 "Valid Change Setpoint Function Numbers", change a setpoint.

5. Remove power from the M-0296, then reapply.

6. Using Table 2, verify that the setpoint changed in Step 4 was stored properly (i.e., remembered after power was removed from the unit).

7. Using Read Setpoint Function Number 39, verify that the RAM Store Cycle value has been incremented by one.

FUNCTION ENABLE

1. Using Function Number 18 from Table 2, check that the proper Function Enable value is stored in the M-0296.

2. Turn off the power and potential inputs to the M-0296.

3. Make sure that the desired functions are disabled using the Function Disable Switch on the Analog-A/D Board.

CALIBRATION

■ NOTE: Complete calibration was performed at the factory with instruments of accuracy traceable to National Bureau of Standards per a Mil-Q-9858A program. If the re-calibration is attempted, please check the certification stickers on all measurement instruments used, to ensure they have not expired. Use only a high precision, well regulated source.

EQUIPMENT REQUIRED

Accurate Voltage source capable of supplying 108.00 to 126.00 V ac at 60.00 Hz.

1. Connect all three P.T. inputs in parallel and tie to the reference source.
2. Connect the power input to the proper ac or dc supply voltage.
3. Connect a dc voltmeter between TP6(–) Ground and TP5(+) V_{ref} on the P–0755 Analog-A/D Board. See Figure 11 for location of the board and Figure 20 for the location of the Test Points.
4. Verify that the V_{ref} voltage is 5.000 V dc. If necessary adjust R16 (V_{ref} Supply) on the Power Supply Board (P–0582) as shown in Figure 23, for 5.000 V dc.
5. Adjust the reference source to 119.40 V ac (99.5%).
6. Adjust R2 (Phase A) on the P–0755 Analog-A/D Board for 3.905 V dc measured from TB6(–) to TP1(+).
7. Similarly adjust R6 (Phase B) for 3.905 V dc measured from TB6(–) to TP2(+).
8. Similarly adjust R9 (Phase C) for 3.905 V dc measured from TB6(–) to TP3(+).
9. If the M–0297/M–0397 option is installed:
   a. Verify that the reading given for Phase A, B and C voltage just toggles the display between 99 and 100% with the source set at 119.40 V ac (99.5%).
   b. Slightly adjust R2, R6 and R9, if necessary, so all phases toggle at approximately the same rate.
   c. Verify proper balance by monitoring the voltage unbalance function. The value should not exceed 1% with all P.T.s tied together.
   d. Verify the voltage reading at other input levels if desired.

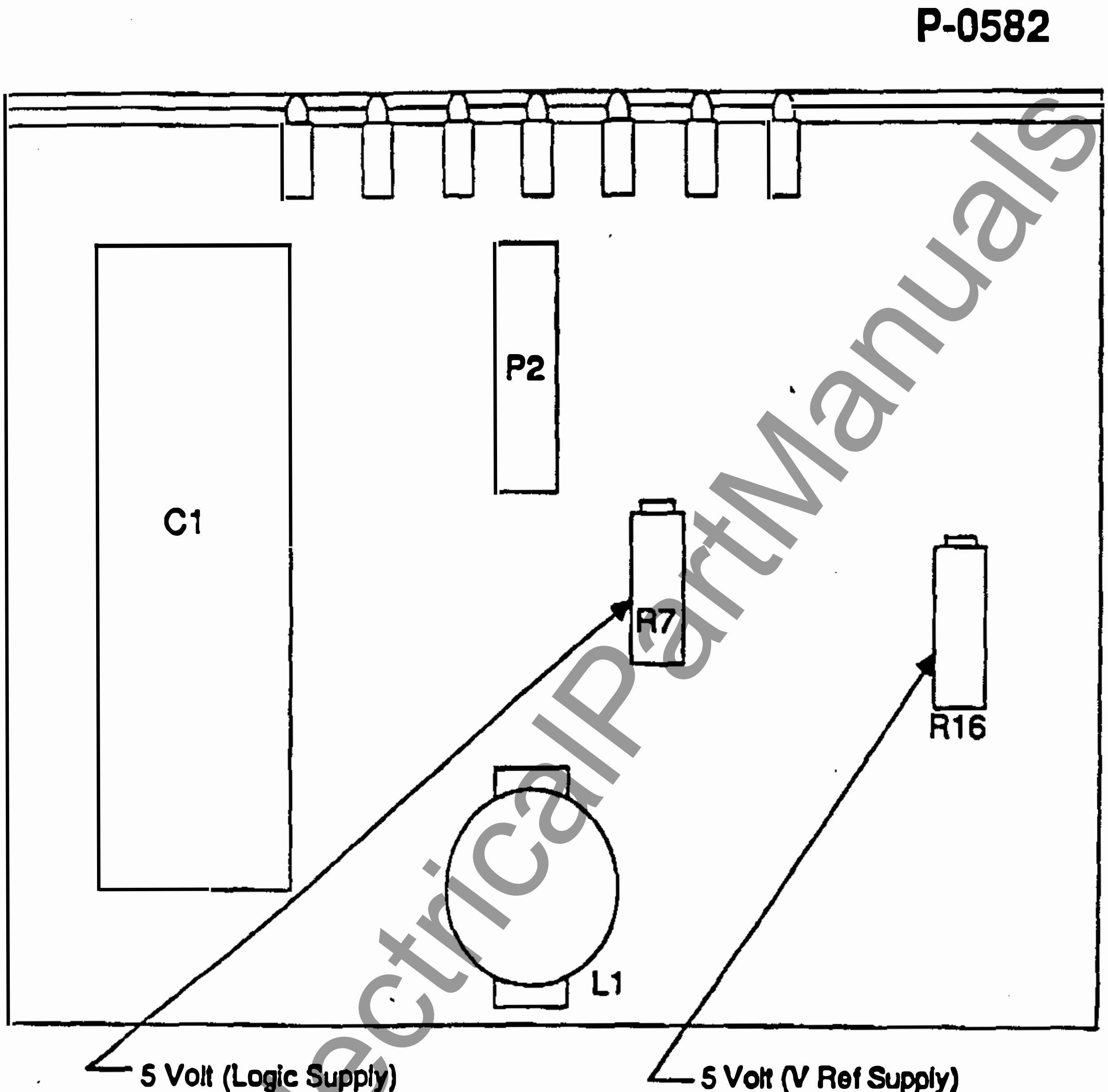


FIGURE 23 Power Supply Board

DESIGN CHANGES

Beckwith Electric maintains a system whereby our customers can be aware of design changes in any of our units. Full documentation on any unit is kept on file by Model Number, Serial Number and, with our microprocessor-based relays, by Software Version.

All units have a Model Number, consisting of a letter and four numbers. Complex changes are recorded by adding a suffix letter. The rule is that it must be possible to use any later version as a replacement for an earlier version. The opposite may not be true because of features added. If later units are not interchangeable for older units, a change in the Model Number is made.

Some simple changes in Software Versions are recorded by Software Version Numbers (for example D0002V02.00).

The following describes the changes that have taken place on the PRIDE® Units.

I. M-0296 SERIAL NUMBERS 0007 to 0009

These units were originally supplied with Software Version D0002V01.XX. This version is not compatible with the Field Adjustment Unit M-0297/M-0397. In order to use the Field Adjustment Unit, the M-0296 relays must be updated. Return the PRIDE to Beckwith Electric for modification if you wish to use the Field Adjustment Unit.

II. M-0296 SERIAL NUMBERS 0010 TO 0048, EXCLUDING 0034, 0042, 0043 and 0044

Relays in this group were originally supplied with software version D0002V01.XX. This software cannot be used with the Field Adjustment Unit. This version does not incorporate all the features described in this book. The unit can be returned to the factory for a modification. Part of the modification will include updating the software for use with the Field Adjustment Unit.

III. M-0296A

These units were supplied with Software Version D0002V02.XX. These units may be used with the Field Adjustment Unit M-0297/M-0397 with the M-0397 software version number D0005V00.XX. This combination will incorporate most features described in this manual. If any of the later software features (those incorporated in the M-0296B or M-0296C) are desired, a software update can be ordered.

IV. M-0296B

The internal grounding on these units was changed to separate signal and power grounds for improved accuracy of the frequency and voltage measurement.

V. M–0296B SERIAL NUMBERS 0042, 0051, 0079, 0084, 0105, and Up

Units with these serial numbers are supplied with a larger terminal block which is mounted vertically on the rear of the PRIDE® when the Semiflush Mounting Option is ordered (see Figure 12).

In addition, the Phase A and Phase C input connections to the terminal block on the M–0296 were changed (see Figure 15).

VI. M–0296C

Units with this suffix letter incorporate all the features described in this manual. This software will work with the M–0397 EE PROM Boards with software D0005V01.XX but will not work with any M–0397 with D0005V00.XX software due to added features.

The following is a list of the latest design changes:

HARDWARE

1. Designed a new box and cover for easier Semiflush Mounting.
2. Added mounting holes for Dc Supply.
3. Modified the transient protection to allow the unit to pass the Fast Transient Test.
4. Designed a new Analog-A/D Board for faster sampling of analog data. The new board includes a four-position dip switch, called the Function Disable Switch, used for overriding various programmable functions. The new Analog-A/D Board is incorporated on units with serial numbers 0800 and above.

SOFTWARE

D0002V03.XX

1. Added a software Trip Counter and storage of the last Self-Test Error (see M–0297/M–0397 Instruction Book).
2. Removed the ability to trip the unit due to an improper phase sequence. This function is now permissive for reconnect only.
3. Changed the operation of the front panel LEDs so that all LEDs, except the POWER OK LED, will remain off as long as the parameters are within the relay setpoints. LEDs will light when the parameters go out of the setpoint ranges.

D0002V04.XX

This version incorporates all the above mentioned features plus:

1. Added ability to program the Output Relay Configuration.
2. Changed the operation of the Trip Targets (see the M–0297/M–0397 Instruction Book).
3. Improved the input noise immunity (ΔF Transient Protection).

D0002V05.XX

Incorporates all the features of D0002V04.XX with the added interface for the faster Analog-A/D Board. The new board is incorporated in units with serials numbers 0800 and above.

■ NOTE: A software update for the M-0296 can be accomplished by exchanging the Memory Board M-0298 located in the Expansion Bus of the relay. Refer to the FIELD ADJUSTMENT section of this manual for this procedure. The Memory Board is marked near the connector fingers on the component side of the board with the numbers "P-0586" and "BE#450-00064". Be sure to consult the factory for details on the update procedure.

▲ CAUTION: Do not swap the M-0298 Memory Board or the M-0397 EE PROM Board between PRIDE® models with suffix "A" or "B" and those with suffix "C" (i.e., between M-0296B and M-0296C), or between M-0296C units with serial numbers below 0800 and those with 0800 and above, since this will cause the PRIDE to misoperate.

WARRANTY

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used therein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of two years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform in accordance with Seller's specifications of the product. Seller shall at his expense correct the same, provided however that Buyer shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to the replacement value of the equipment furnished under this contract. The foregoing shall constitute the exclusive remedy of the Buyer and the sole liability of the seller and is in lieu of all other warranties, whether written, oral, implied or statutory, except as to the title of the Seller to the equipment furnished. No implied statutory warranty of merchantability or of fitness for a particular purpose shall apply. Seller does not warrant any product or services of others which Buyer has designated.

SELLER MAKES NO WARRANTIES EXPRESSED OR IMPLIED OTHER THAN THOSE SET OUT ABOVE. SELLER SPECIFICALLY EXCLUDES THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION CONTAINED HEREIN. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL, EXEMPLARY, OR PUNITIVE DAMAGES OF WHATEVER NATURE.

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

INDEMNIFICATION

The Seller shall not be liable for any property damages whatsoever or claims of any kind whether based on contract, warranty, tort including negligence or otherwise, or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary or consequential damages including, but not limited to loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder or any services furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site and all premises used for such operations. It is the intention of the parties that this is a complete indemnification and hold harmless agreement in regard to all claims arising from nuclear operations of Buyer. 067